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ECONOMIC VALUATION OF POTENTIAL LOSSES OF FISH POPULATIONS IN THE SWAN RIVER DRAINAGE

FINAL REPORT

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Prepared by:

ECO Northwest

For:

Montana Department of
Fish, Wildlife, and Parks

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SUMMARY

I. INTRODUCTION

A. The Federal Energy Regulatory Commission has received several applications for the construction of small-scale hydroelectric plants on tributaries of the Swan River. The value of these plants depends on the extent to which the benefits they generate (primarily electric power) exceed their costs (primarily construction and environmental damage). Among the likely environmental costs is a reduction of populations of fish, with an accompanying reduction of the quality of sport-fishing. The primary purpose of this report is to estimate the value of recreational fishing in the Swan River drainage relative to other sites in Montana, and the costs to society of a reduction in fish populations and fishing quality in the drainage.

B. We examined eight economic techniques that potentially could estimate the value of recreational fishing (see Appendix A). From those we selected the three most likely to answer our questions about the value of fish loss. The <u>contingent-valuation</u> approach estimates value from the responses of fishermen to a direct question about a hypothetical (contingent) situation: How much would you pay so that fishing quality would not decrease by 25%? The <u>simple travel-cost</u> approach uses information about how far fishermen will travel to fish at a specific site to estimate the total value they place on that site. The <u>hedonic travel-cost</u> approach combines data on travel cost with detailed information about the characteristics of different fishing sites (e.g., average size of catch, scenery) to estimate the value of each characteristic, including the size of the fish population.

II. RESULTS

A. CONTINGENT-VALUATION APPROACH

1. The economic survey asked three contingent-value questions at eleven different fishing sites, including Swan River, Swan Lake, and their tributaries. Half of the respondents, chosen at random, were asked about their willingness to pay (WTP): How much money would you be willing to donate each year to prevent a permanent decrease in fish population in the XYZ River drainage by 25%? The other half were asked about their willingness to sell (WTS): How much would you have to be compensated per year if there were a permanent decrease in fish population in the XYZ River drainage of 25%? All respondents, as a check on their answers to either WTP or WTS, were asked about willingness to drive (WTD): Given the 25% reduction in fish population, how many more one-way miles would you drive to get to a site whose quality is as good as that in the XYZ drainage before the reduction? We assume that the responses to the WTP, WTS, and WTD questions measure the value to fishermen of the 25% loss in fish populations.

2. The average (mean) value of fishing as determined by WTP responses (we abbreviate that phrase as 'mean WTP') for all sites was $35 per year with a standard error of 34.8; mean WTS was $386 per year, with a standard error of 441; mean WTD was 106 miles, with a standard error of 41.9. Neither the WTP nor WTS responses for the whole sample were significantly different from zero.

3. When examined site-by-site, mean values for WTP responses were significant in eight of the eleven sights, and varied from $11 to $36 per year. Mean WTS was significant at four of eleven sites, and varied from $25 to $1,172 per year. Mean WTD was significant at all sites, and varied from 46 to 178 miles per trip. If statistically insignificant results are included, the Swan River had the highest mean WTP, $76 per year. Kootenai River had the highest mean WTS, $1,172 per year.

4. By any of several tests, the responses to WTP, WTS, and WTD seem inconsistent.

a. Many sites with significant mean values for WTP did not have significant mean values for WTS, and vice versa.

b. The relative rankings of sites based on WTP and WTS differed markedly (but rankings based on WTS and WTD were very similar).

c. Mean WTS is over six times mean WTP for nine of the sites.

d. Large mean values determined by WTP responses were not matched by large mean values determined by WTD responses; i.e., sites high on one measure were not high on the other.

5. To evaluate the power of the contingent-valuation approach, we performed a number of hypothesis tests about the relative value of the sites. We tested whether sites were statistically different when compared on WTP, WTS, or WTD measures (given the mean values, standard errors, and number of responses). The WTP and WTS variables performed poorly, WTD slightly better. Nor were they able to distinguish sites that appeared to be superior based on other criteria (e.g., Bighorn and Swan Rivers) from other sites. All statistical tests suggest that the contingent-valuation questions in this study, as indicators of the value of fish populations to fishermen, had little ability to distinguish between high-quality and average fishing sites. We also found no significant relationship between social and demographic variables that should affect demand (like income and age), and WTP or WTS (which should be measures of demand).

6. A major problem with WTP and WTS responses is that they are highly skewed. A few repondents gave very large values,

which had the dual effect of biasing the results upward and reducing our confidence that the results constitute reliable representations of the true value the society of fishermen ascribes to fishing at these sites. For example, the median response to WTP questions at different sites ranged from $3 to $25, whereas the mean ranged from $11 to $76; for WTS the median ranged from $0 to $25 (8 of the 11 sites had a median of 0), whereas the mean ranged from $15 to $1,172.

B. SIMPLE TRAVEL-COST APPROACH

1. The simple-travel cost method estimates the value of a fishing site to fishermen by observing how far they will travel to fish at the site. It constructs a demand curve for trips to the site by observing the number of trips per year fishermen will make from different distances. The demand curve shows the value a fisherman places on the site. If we subtract from that value what it costs a fisherman to get to the site (travel costs), we are left with the net value of the site to a fisherman: how much the site is worth to him or her <u>in excess</u> of what it costs to get there. The sum of this excess value (called "consumer surplus") for all fishermen gives an estimate of how valuable a site is to society.

2. To estimate the demand for trips (visits) we first determined visitation rates (visits per year) for all eleven sites we studied. We then regressed visitation rates on the price of a visit and other variables that likely would have an affect on the demand for visits (e.g., income, age). The price of a visit is the cost of traveling to the site, which we measured in one-way distance from an origin to the site. We converted this distance to cost by multiplying by a travel cost of $.25 per round-trip mile (which is the same as $.50 per one-way mile).

3. The slope of the demand curves for the eleven sites we analyzed were similar. That result allows us to compare just the intercepts of the demand curves. Sites with greater intercepts have higher demand curves. Since all demand curves are roughly parallel (have equal slopes), for any given distance sites with greater intercepts must produce greater consumer surplus (the difference between travel cost and marginal value as measured by the demand curve) and, hence, must have greater net value.

4. Comparison of the intercepts of the simple travel-cost demand curves for the eleven sites suggests that sites can be divided into three groups on the basis of their relative quality as perceived by fishermen. Higher-quality sites are Bighorn River, Flathead River, and Flathead Lake; medium-quality sites are Kootenai River, Hungry Horse, Lake Koocanusa, and Ashley Lake; lower-quality sites are Swan River, Swan Lake, Swan Tributaries, and Thompson River.

5. Compared to the contingent-valuation method, the travel-cost method was able to make sharper distinctions about the quality of sites.

C. HEDONIC TRAVEL-COST APPROACH

1. The hedonic travel-cost approach allows us to estimate the value of a partial loss of fish (rather than the value of the total site, as in the simple travel-cost approach) by estimating the unique contribution of each key characteristic (such as average number of size of fish caught, or scenic quality) to the total value of different fishing sites. We estimate the marginal value of each characteristic by observing the extra distance people travel to reach sites with more of particular characteristics.

2. In the first stage we regress, for each origin, travel cost on the characteristics of the site visits. In the resulting equation the coefficients of the site characteristics can be interpreted as their prices, telling us how much more or less travel cost fishermen will be willing to incur as the levels of characteristics change.

3. The characteristics we looked at were catch per day, size of largest fish caught, scenery, management designation, and target species (for bull trout and trout). All were statistically significant except scenery and management designation; we dropped these two from our final equations. The final regressions were not completely successful, since some coefficients from some origins were negative, indicating that fishermen would pay more to get less of what most of us would believe to be positive characteristics. Given this problem we must use cautiously averages that include these negative values. Given this caveat, we found the value of targeting bull trout to be very large: fishermen, on average, value a trip to fish for bull trout at $450. For trout the value is $30 per trip. The value of adding another inch to the size of the largest fish caught is about $1. The number of fish caught had, on average a negative coefficient, suggesting that the quality of fishing rather than quantity of fish is what is important to fishermen in Montana.

4. Catch rates, size, and targeting bull trout all have elastic demand functions near the mean of the sample. That is, what fishermen are willing to pay for a little more of each of these characteristics does not change very much with the level of characteristics purchased. The price of these characteristics can be used as a reasonable approximation of the average value of the characteristic across a broad range of values.

D. CONCLUSIONS

1. The three different methods we used to rank Montana fishing sites and estimate their value did not yield consistent results, as the table below illustrates. Rankings based on willingness-to-pay are the most different from all others.

RELATIVE RANKINGS OF SITES

	CONTINGENT VALUATION: WTP	CONTINGENT VALUATION: WTS	CONTINGENT VALUATION: WTD	REVEALED PREFERENCE: Travel Cost
HIGHER QUALITY	Swan River	Kootenai Flathead Lake	Flathead Lake Kootenai Bighorn Swan River	Flathead Lake Bighorn Flathead River
MEDIUM QUALITY	Bighorn Swan Lake Kootenai Flathead River	Bighorn Swan River Swan Lake Koocanusa	Koocanusa Swan Lake Thompson Flathead River	Hungry Horse Koocanusa Kootenai Ashley
LOWER QUALITY	Koocanusa Hungry Horse Flathead Lake Swan Trib. Ashley Thompson	Hungry Horse Swan Trib. Ashley Thompson Flathead River	Swan Trib. Ashley Hungry Horse	Thompson Swan River Swan Lake Swan Trib.

2. The contingent-valuation measures were generally unable to distinguish among sites, despite the fact that the sites we examined are generally held to be of different quality. The travel-cost method was able to identify seven of the eleven sites as different from the average.

3. All contingent-valuation measures (willingness-to-pay, -sell, and -drive) ranked Swan Lake and Swan River more highly than the travel-cost method did.

4. The contingent-valuation method could not distinguish between the species of fish, the number of fish, or the size of fish. That is, despite the fact that these variables vary over all eleven sites, the contingent-valuation method valued a 25% loss of the existing fish population equally at each site. In contrast, the hedonic travel-cost method suggests that fishermen

care a great deal about species, especially trout and bull trout, and to a lesser extent about size of the largest catch. The loss of 25% of a fish population in general is not worth a great deal to fishermen. However, the loss of an opportunity to fish for trout or bull trout <u>is</u> worth a great deal. The policy implications of the results of the contingent-valuation and hedonic travel-cost methods are consequently quite different.

5. As with relative rankings, the different methods we used provide different estimates of the value of a 25% loss of fish. The table below summarizes our results.

AGGREGATE VALUATION OF A 25% FISH LOSS BY METHOD[a], DOLLARS/YEAR

	—Contingent Valuation—			—Revealed Preference—	
	WTP	WTS	WTD	Travel Cost	Hedonic Travel Cost
Swan Lake	72,500	602,500	74,182	265,000	64,000
Swan River	190,000	1,562,000	114,000	455,000	69,000
Swan Trib.	8,265	111,000	25,000	68,000	36,000
TOTAL	271,000	2,275,000	213,000	788,000	169,000

[a] All of these estimates are contingent on the uncertain total visits and total number of fishermen at each site per year. See the text for a discussion of the statistical reliability of each estimate.

The estimates of using the simple travel-cost estimates are not strictly comparable with the other estimates. The travel-cost estimates are a measure of the total value of the site to fishermen, not just a 25% loss in fish. Consequently, they should be viewed as an upper bound on the value of the fish loss to fishermen. The willingness-to-sell responses exceed this upper bound, suggesting these responses are biased upwards. The remaining estimates all fall below the travel-cost estimate as expected. The willingness-to-pay responses, although below travel-cost estimates, are 25% above the willingness-to-drive and 60% above the hedonic travel-cost measures on average. The willingness-to-drive and the hedonic travel-cost measures have surprisingly good correlation. It may well be that people can give clearer responses to how many miles they would have to drive rather than how many dollars they would be willing to pay for an environmental amenity.

I. INTRODUCTION

A. BACKGROUND

The shock of rising energy costs in the early 1970's led to increased interest in the feasibility of small hydroelectric generating facilities. By 1983 the Federal Energy Regulatory Commission had received 22 applications for micro-hydroelectric permits on tributaries of the Swan River, at or above Swan Lake. The Swan River drainage currently provides habitat for trout, salmon, and whitefish, and is a popular sport-fishing area in Northwestern Montana. The Montana Department of Fish, Wildlife, and Parks (MDFWP) and the U.S. Fish and Wildlife Service rate the Swan River as a Class 2 fishery resource (high priority) and most of its tributaries as Class 3 (substantial fishery resource value). Micro-hydroelectric development has the potential of reducing that habitat and causing the accompanying partial loss of fish populations and sportfishing opportunities. At the most general level, the purpose of this study is to provide information that will help managers evaluate the unavoidable tradeoffs between hydroelectric power and fish.

To determine the value to society of the potential hydroelectric projects, we must know not only the benefits society receives from more or cheaper electricty, but also what society gives up when such projects are built and operated. Damage to the natural environment is an inevitable concommitant of such projects, and is a cost society must consider. (The recently released plan of the Northwest Power Planning Council reinforces this point.) Among the environmental costs are the losses of fish population. To evaluate these losses, we need to answer two distinct questions. The biological question is: By how much will these projects reduce fish populations? Given an answer to this question, an economic question follows: What is the cost to society of these expected reductions? The purpose of this study is to provide the information and analysis necessary to answer the economic question; other researchers will work independently on the biological question.

To begin to estimate the value of potential fish losses we reviewed eight techniques that economists have used to estimate the value of outdoor recreation (see Appendix A of this report). From those techniques we selected the three we determined most likely to answer our questions about the value of a loss of fish. In additon to the brief descriptions of the techniques that follow, we describe them in more detail in Sections II and III, and in Appendix A.

All three techniques attempt to measure the value of the total fish loss by looking at the values to individuals of the fish lost. The total value to society of the fish loss is the sum of what all individuals are willing to pay to prevent the loss. In this study we limit our analysis to the tastes and behavior of the individuals we sampled. Neither our budget nor

our work program envisioned our estimating the total number of individual trips made from all residential origins to the eleven Montana fishing sites we examined. Our emphasis is on the relative value of these fishing sites; i.e., do people, on the average, value the fishing more at Swan River than at Kootenai River? We also estimate the prices fishermen will pay for the various aspects of the fishing experience (e.g., type, size, and number of fish caught). Our results, if combined with detailed information on site visitation, comprise the key economic data necessary for estimating the total value of fish lost at a particular site.

The **contingent valuation** approach relies on responses of fishermen in the Swan River drainage to questions such as, "How much would you pay so that fish populations would not decrease by 25%?" While one might initially expect a summation of responses to this direct question to be exactly the estimate we seek, the theoretical literature of economics and many professional studies suggest a large divergence between how people say they will respond (to a hypothetical situation) and how they actually respond (to a real situation). Economists typically favor observing actual behavior when trying to infer values.

In our analysis we use two techniques that are based on the actual behavior of fishermen who choose among a variety of potential fishing sites, some near and some far. The **simple travel-cost** method provides an estimate of the total value of a recreational fishing site to fishermen by observing how far people will travel to fish in the Swan River drainage. Estimates derived using this method reflect the cumulative value of all aspects of fishing at a particular site--the fishing itself, the scenery, and so on--and, hence, provide an upper bound on the value of the partial fish loss to fishermen, a subset of the value to all members of society (though one could argue that on heavily-fished streams the value to fishermen captures a very large percentage of the entire value to society).

The simple travel-cost method constructs a demand curve for trips to the site by observing the number of trips per year fishermen will make from different distances. The demand curve is a graphic or mathematical representation of the relationship between the value a fisherman places on additional fishing trips to a site and the total number of trips he has already purchased. Theoretical and empirical work suggests that the value of each new unit of a good (in this case, fishing trips) declines as more of the good is purchased. The travel cost for each fisherman becomes the price of each additional (marginal) trip. In our analysis we construct demand curves for eleven different fishing sites. The value of each site is the sum of the difference between value (the demand curve) and cost (travel cost, estimated as a function of distance traveled). Economists call this difference "consumer surplus," i.e., the difference between how consumers value a resource and what they have to pay to use it. In this case, consumer surplus reflects how valuable a fishing site is and how much should be spent to preserve it.

The simple travel-cost technique estimates the value of the total site. It estimates the value of the whole bundle of site characteristics (such as scarcity, and type and size of fish). Thus, in some sense, it is inappropriate to use this approach to value a single characteristic (in this study, fish population). We suspect, however, that the primary difference in the way fishermen value the sites in our sample results from the type, size, and quantity of the fish in each water body. In other words, qualitative differences among sites likely result from differences in fish population. Sites with "better" fish populations, other things equal, should be more highly valued. Our analysis across eleven sites permits a test of this hypothesis as an additional check on the travel-cost and contingent-valuation techniques.

The third technique, also based on observable behavior, is the **hedonic travel-cost** method, a more sophisticated version of the simple travel-cost method. The technique allows us to estimate the value of a <u>partial</u> loss of fish (rather than the value of the <u>total</u> site) by estimating the unique contribution of each key characteristic (such as average number or size of fish caught, and scenic quality) to the total value of different fishing sites. By looking separately at the value of different characteristics of a site, one can focus on how a partial fish loss, alone, will affect the site's recreational value. In the first stage of the approach, one estimates the marginal price of each characteristic by observing the extra distance people travel to reach sites with more of particular characteristics. In the second stage, one estimates the demand for each characteristic. The price of the characteristic reveals how much an average consumer values small changes in the amount of the characteristic available. The consumer surplus, the area under the demand curve, reflects the value of larger (non-marginal) changes in the amount of the characteristic available.

Our definitions of value, price, and cost are consistent for all three techniques. In theory, our interest is in the <u>value</u> of the population of fish. We assume that the value of fish derives exclusively from their value to sport fishermen. (They may be additionally valuable for researchers, environmentalists, or for their role in the ecosystem. To the extent these other users value the lost fish, we underestimate the total value of fish.) We cannot observe value directly, but we can make estimates of the <u>price</u> people will pay for quality fishing, either by asking them directly (as in contingent-valuation techniques) or by observing the <u>cost</u> they incur to fish (as in the travel-cost techniques, where the cost shows how much people actually pay to gain access to sites with more or better fish).

B. ORGANIZATION OF THE REPORT

Our report contains three major sections. Section II describes in more detail the three analytical techniques we used, the data they require, the survey we designed to gather those data, and how we conducted the survey. Section III contains the results of our three analyses: contingent valuation, simple travel cost, and hedonic travel cost. Section IV contains our conclusions about the value of the Swan River drainage as a site for recreational sport fishing and about the usefulness of the analytical techniques we employed. The Appendices contain the technical information supporting Sections II-IV.

II. METHODOLOGY

A. ANALYSIS

1. Contingent Valuation

We designed the contingent-valuation questionnaire in consultation with staff from MDFWP. We asked fishermen either how much they would be willing to pay to prevent a 25% loss of fish in the Swan River drainage, or, how much they would have to be paid (also called "willingness to sell") to compensate them for a 25% loss of fish.

A recurring problem for researchers using the contingent-valuation method is the persistent difference between responses to willingness-to-pay and willingness-to-sell questions. Although economic theory predicts that willingness-to-sell responses will be larger because of the added income from "owning" the resource, economists expect the difference in response to be small. The added wealth a recreational fisherman gets from having the right to fish on a single river or lake rather than having to pay for access is not likely to be large. Further, the additional income is rarely observed to increase substantially how much people value recreational sites. The difference between willingness-to-pay and willingness-to-sell of a factor of eight or more throughout the literature on contingent valuation is consequently an anomaly. Willingness-to-pay or willingness-to-sell responses, or both, must be biased. To learn more about these potential biases we asked both types of questions.

As a further test of whether the willingness-to-pay question implicitly contained a bias, we posed a third contingent-payment question. Instead of paying in forgone income, we asked fishermen how many extra miles they would drive to obtain a level of fishing quality equal to that in Swan River. Our intent was to get a less-hypothetical response from the user. Presumably, the user could more accurately state where else he would travel than he could the amount of a hypothetical payment into a vaguely defined fund. The drawback of the question, however, is that one must convert miles into dollars. To facilitate this conversion, we have asked questions about people's wage rates, which helped us estimate the value people place on travel time. In our final analysis, we used compensation rates typically paid by business and government for work-related mileage, and argued that such rates actually include some small compensation for travel time (we explain this in more detail in Section III-C).

We designed our contingent-valuation questions to avoid other types of bias. To avoid biasing responses by persistent prodding or by suggesting a minimum initial bid, we made these questions open-ended. We described fish loss in terms of a permanent population decline of 25% because fishermen are accustomed to adjusting to natural fluctuations of fish populations in

different years. The fishermen's responses to these short-term losses would clearly be different from their reactions to longer-term declines. Brief tests of this hypothesis using a preliminary test of the questionnnaire tended to support this assumption.

2. Simple Travel Cost

The travel cost from residence to a recreation site is part of the cost of using the amenities the site offers. In fact, travel cost is part of the cost of all of our daily purchases. But because the distance and, therefore, the travel cost, is typically small (especially compared to the price of goods purchased) we tend to ignore travel cost when thinking about the price of traditional goods. For outdoor recreation sites, though, the purchase price is usually zero or very small, whereas the distance traveled can be quite large. For outdoor recreation, the travel cost can be the bulk of the price of a site.

The travel-cost technique derives from basic microeconomic theory. In a given season, people will continue to travel to a site until the recreational value of one more trip is equal to the price paid or cost of the trip. Thus, the value to a user of the <u>last</u> trip (the "marginal" trip) he makes to a site is equal to the price he pays for it, which is equal to the cost of traveling to that site. But previous trips the "inframarginal" trips are generally worth more than the marginal trip. For almost all consumption goods, people value each additional unit of the good less than the previous unit. Thus, a fisherman's first trip to a fishing hole is worth more to him than his second, third, and subsequent trips.

The critical issue in determining the value of a site is estimating how much more than the marginal trip the inframarginal trips are worth. The net value of a site is the difference between the benefits it provides and what users pay to get those benefits. What they pay is travel cost, which we assume does not vary with the number of trips made (i.e., the costs of marginal and inframarginal trips are equal). For every inframarginal trip, users get benefits beyond the value of travel costs. The sum of these extra benefits to all users is the net value of a site.

The travel-cost method developed by Hotelling (1949) and Clawson (1959) infers the value of inframarginal trips by observing the number of trips made to a site by people who live different distances from the site. Because they live different distances, they face different prices (travel costs) for use of the site. If we assume the people are otherwise alike, then the different numbers of trips people take result entirely from the different prices (distances) they face. We can infer the value of the inframarginal trips for a person close to the site by looking at the value persons far from the site place upon their own marginal trips. For example, if people 100 miles away go to

a site only once, the first trip (at, for example, $.20 per mile) is worth the round-trip cost, or $40 (2 x 100 x .20). If people 90 miles away go to the site only twice, the second trip is worth $36. If people take three trips when they are 80 miles away, the third trip is worth $32. The value of inframarginal trips can be measured by looking at the cost of the last trip taken by users who take fewer trips.

The net value of a given site to a user is the amount above the travel cost that she will pay for each trip. The net value of the marginal trip is zero. For example, if one took the above site away from the people who lived 100 miles away, they would lose a trip which they value at $40, but they would save $40 of expenses. The net loss to these people is zero. If one takes the same site away from the people who live 80 miles away, they would lose three trips. The first trip they would value at $40, the second at $36, and the third at $32. They would, however, save the travel expenses of three trips, at $32 each. The net loss would be $12 (($40+$36+$32)-(3 X $32)). Twelve dollars is what the users 80 miles away should be willing to pay for the all-or-nothing privilege of having the site exist. This net value is the <u>consumer surplus</u> of trips to the site--it is the sum of the values of the inframarginal trips made by an individual, and the appropriate measure of the individual's value of a site.

We used the travel-cost technique to construct demand curves for eleven different fishing sites and compare them to determine their relative values. For each trip origin (zipcodes, at a known distance from the site) we constructed average measures of socioeconomic characteristics (to control for their effects on the number of trips to the site). Then, with each origin zipcode as a single observation we regressed a measure of the number of visits to the site on distance and other socioeconomic variables. The relationship between distance (price) and visitation rate (quantity) describes a demand curve for trips. The demand curve for trips can be used to estimate how each individual would value a site given its distance. The distance determines the travel cost, or price, of a visit. The value is the area under the demand curve: how much people would be willing to pay for a site. The net value is the consumer surplus, the area under the demand curve and above the price.

Sites may be of greater value simply because they are more <u>accessible</u> by more people: even a site with only average fishing can be very valuable if it gets heavy use because of its proximity to an urban area. Our focus, however, is how the <u>quality</u> of the site may affect the value of a site. We therefore control for accessibility by assuming the distance to all sites to be the same. The difference in consumer surpluses across sites consequently will reflect only differences in the quality of each site. In many of our analyses, we find the slopes of the demand curves for different sites to be the same. That finding simplifies our analysis: it means that the consumer's surplus, which is our measure of value, must be directly proportional to

the visitation rate for any given price. At a given price per trip, the site with the greatest visitation rate has the highest quality. The results of this type of analysis allow us to rank the different sites qualitatively.

3. Hedonic Travel Cost

The hedonic travel-cost method is designed to measure the value of site characteristics, not the total value of an individual site. To get the data this technique requires we asked each fisherman we interviewed to rate the site characteristics of three places he had fished the previous year. Economic theory and common sense predict that fishermen will travel greater distances to get to sites of higher quality (i.e., sites with higher ratings for site characteristics). By traveling the extra distance, they demonstrate that they value the extra quality at least as much as the additional cost. Given the existing set of sites available to a user, the marginal value of a characteristic is the extra travel cost he must pay to reach a site with slightly more of that characteristic. We computed the travel cost from each fisherman's residential location to sites of varying quality, using his estimate of distance and our estimate of cost per mile.

For each residential origin (zipcode) we examine up to three of the favorite sites visited in the previous year by each fisherman we interviewed from that origin. (In our survey, we asked each fisherman for information about the three sites he visited most frequently during the previous year.) We assumed each site derives its value from the bundle of characteristics (e.g., fish size, scenery, type of fish) it offers. The cost of purchasing the bundle is the cost of gaining access to the site, which is the travel cost of a visit. To estimate what fraction of this cost should be attributed to each characteristic, we regressed the price of the total bundle (the travel cost) on the characteristics:

$$(1)\quad \text{Value}_i = \text{Travel Cost}_i = P_{1,i}Q_1 + P_{2,i}Q_2 + \cdots + P_{n,i}Q_n$$

where n is the number of characteristics, Q_k is the quantity of characteristic k, and $P_{i,k}$ is the value of a unit of Q_k from origin i. Note that the prices are different for different origins. The three key characteristics we used to measure the quality of each fishing site were average number of fish caught per day (by species), average size of fish caught (by species), and a subjective rating of the relative scenic quality (below average, average, above average). We then regressed travel cost on the bundle of characteristics each user purchases $(Q_1, Q_2, \ldots, Q_n)$ to estimate marginal prices $(P_1, P_2, \ldots, P_n)$ people from that residential area will pay for each characteristic. The estimation from equation (1) produces a set of prices for characteristics. Those prices represent what fishermen are willing to pay (measured in increased travel cost) for more of each characteristic.

With the hedonic travel-cost technique, one infers values for various site characteristics by observing the choices fishermen make about which sites to visit from the range of sites available. If all sites were alike, the rational fisherman would just visit the closest site. Fishermen venture to more distant sites because those sites have better quality. The extra distance each fisherman will drive to get more of a characteristic reflects the value of that characteristic to him. For example, if a fisherman will drive ten extra miles to go from a five-fish-per-day site to a six-fish-per-day site which is otherwise similar, the value of a fish per day is the round-trip travel cost of ten miles.

For a single small hydroelectric project, the results of this first stage of the analysis are probably sufficient to measure the value to various users of a partial reduction of the fish population. But for large changes in fish population, such as might occur if several small hydroelectric projects were developed, prices will change: the prices estimated in equation (1) will no longer be good estimates.

Because demand curves are downward sloping, what people will pay for a unit of fish population will depend on the overall level of fish population. Specifically, as the fish population across many streams falls, the value of a unit of fish population will rise. To cope with such changes, we must estimate a demand curve for each of the three site characteristics so we can see what happens to price as the quantity of fish changes. Thus, in this second stage, we tried to estimate how the marginal willingness-to-pay for a characteristic, P, changes with the level of the characteristic, Q, controling for all other Q's and demographic variables. The coefficient estimated for the variable Q_i in the equation below is the appropriate measure of this change in willingness-to-pay. For the estimated demand curve, we can calculate what people are willing to pay for non-marginal changes in the amount of characteristics. In this stage, we analyzed the users from all the residential areas. We estimated the demand curve for each characteristic by regressing the price of a given characteristic (P_i) upon the level of the characteristic users are observed to purchase and demographic variables (W) such as age, sex, or income:

$$(2)\ P_i = a_o + a_1 Q + a_2 Q_2 + \ldots + a_n Q_n + f(w)$$

where a_i is a coefficient telling us how P_i will change as Q_i changes. Note that the coefficients a_o through a_n are the same for all origins. The P_i used in equation (2) are the estimated prices from equation (1). The demographic variables control for some of the differences in tastes we might expect from people of different incomes, age, or other socioeconomic characteristics. The use of these control variables allows us to isolate the effect of a change in the quantity of a characteristic on its price. Equation (2) describes the demand curve for each characteristic. The area under the demand curve between the current level of fish population at Swan Lake and the likely new

level (for example, after a new hydroelectric project) is an estimate of the value of the fish loss (see Figure 4 in Appendix A).

B. SURVEY

1. Design

In May, 1983, ECO reviewed the survey used by MDFWP for its creel survey, and designed a series of economic questions that could be appended to the creel survey. We suggested some changes in the form used for the creel survey, and in the location of the economic questions within that form. The questions we asked relate directly to the data we need to use the three analytical techniques described above. In general, the questions covered residential location, distance traveled to the site, fishing experience, income, the average catch, size, target species at each site, a subjective measure of scenery, and contingent-valuation questions. For contingent-valuation questions, half of the fishermen were asked about willingness-to-pay, the other half about willingness-to-sell; all were asked about WTD. Appendix B contains the actual questions.

We made a preliminary test of the questionnaire in May 1984. ECO staff instructed and observed the interviewers; we found no major changes necessary. During the first two months of interviews staff at ECO and MDFWP clarified any remaining ambiguities or inconsistencies that occasionally surfaced. In general, we have no reason to expect that the questions or their presentation introduced a systematic bias into the responses we received.

2. Administration

The staff from MDFWP conducted the surveys for economic information in conjunction with their creel surveys. On Swan Lake, the census clerk worked from a boat (until the lake froze), estimating the number of boats twice a day, and interviewing as many parties as possible. On Swan River and tributaries, the census clerk interviewed fishermen on the banks, with an estimate of the number of parties fishing made once a day by airplane. The census clerks obtained some information from check stations set up on the Swan Highway and at the town of Swan Lake. During the summer season each clerk worked eight 10-hour days in a 14-day period: five days during the week and three days on weekends.

The census clerks originally tried to have all members of a party read and complete the economic section of the survey. This method led to collaboration, as members of the party would compare and modify answers. We quickly rejected this method in favor of asking the questions to only the one member of the party who was its leader or was otherwise willing to answer the questions.

Staff at MDFWP transferred all survey information from the survey forms to coding sheets for data processing. Rob Mendelsohn (ECO) supervised keypunching and proofreading of the data. To be able to run the travel-cost model we had to control for the population and the characteristics of the average fisherman from each zipcode. To do this we needed information from the 1980 U.S. Census arranged by zipcode. After we entered all the survey data we generated a list of zipcodes and then purchased from National Planning Data Corporation demographic data (including their proprietary estimates of 1983 population and income) by zipcode. We appended demographic data for the appropriate zipcodes to each record (i.e., to each interview).

To expedite the production of a final report, we began our analysis of the data in March, 1984, before all interviews were completed. (We had all the data for the 1983 season, which ended in November.) As a result, we did not include in our regressions approximately 33 interviews that occurred in January and February during the ice-fishing season on Swan Lake, nor did we include approximately 20 interviews that staff at MDFWP expected to occur between March and May, 1984. Thus, our analysis applies only to the main fishing season, May to November.

Both ECO and MDFWP have a computer tape of the complete economic data for all sites.

III. RESULTS

A. INTRODUCTION

We used three techniques to analyze the economic data: contingent valuation, simple travel cost, and hedonic travel cost. We describe our results for each technique in the three sections that follow. We compare the results of the three techniques in Section IV, Conclusions.

For clarity and brevity, we present in this report only those data germane to our final analysis. For example, though we asked questions about trip purpose and the renting of nearby summer residences, we found these variables insignificant, adding no explanatory power to our regressions. Hence, we do not report on them. Similarly, we do not present detailed descriptive statistics on all economic variables, since those descriptions have no bearing on our analysis. MDWFP has the computer tape with all data and can easily produce frequency distributions and crosstabulations by site if a need arises for such statistics.

Nevertheless, a brief overview of the magnitude of the key variables provides a useful introduction to our more detailed analysis. Although there are 942 observations in the entire survey, depending on the analysis, some observations were eliminated because of missing data. Table III-1 shows the number of observations for each of the eleven sites we evaluated. The average catch for the sample was 5.2 fish per day, and the average size of the largest fish in the catch was 16 inches. Almost two-thirds of the fishermen fish primarily for trout; only two percent fish primarily for bulltrout. The average age of fishermen in the sample was 44 years; they had been fishing an average 30 years prior to the survey year. Average family income for the sample is $34,000; the mean wage was $16 per hour.

B. CONTINGENT VALUATION

As part of the valuation of the Swan drainage and other Montana rivers, we asked three questions requiring contingent valuations. We asked half of the sample, randomly selected, a question about willingness-to-pay (WTP); the other half about willingness-to-sell (WTS) (how much they would have to be paid). We asked everyone a question about his willingness-to-drive (WTD) additional miles (see Appendix B). All of the questions focus on the value of a 25% decrease in the fish population at the site. Altogether, the staff at MDFWP sampled eleven fishing sites.

Note that these three contingent variables (WTP, WTS, WTD) are alternative ways of estimating the same thing: the value of a 25% loss of fish population. Ideally, one wants all three measures to be statistically significant and equal (which would indicate consistency). If we can show statistical significance of a given measure (like WTP) across the eleven sites for which

we have data, we have confidence that the measure is internally consistent: responses are not random or wildly divergent. If all three measures were also approximately the same for all eleven sites, we have confidence that the three measures are externally consistent: they are measuring the same thing and giving consistent evidence about the value of the three variables. If we find both statistical significance and consistency, then we feel confident that our measures are good approximations of the "true" value of the fish loss. As we expected, however, we did not get such neat results: some measures were insignificant at many sites, and the estimated values diverged markedly. These facts make it difficult to say what the true value is. To interpret the contingent-value results, we believe one needs other, independent measurements. One such measurement would be expert opinion: for example, which of the contingent-value variables yields site rankings that approximate those of staff at MDFWP? (An obvious problem with this approach is its circularity: the economic questions are supposed to give MDFWP an independent ranking of sites). Another measurement method is revealed preference: what ranking and value of sites is implied by fishermen's behavior? The travel-cost approach (both simple and hedonic) supplies this type of measurement. We use our results from our travel-cost analysis to check and refine our analysis of contingent valuation.

Considering all sites together, the average (mean) value of the fish loss as estimated by WTP was $35 per year. (For the rest of this report we will abbreviate the phrase "mean value of the fish loss as estimated by" as "mean", for example, mean WTS.) In other words, for all fishermen surveyed at all eleven sites, the average amount any single fisherman would pay per year to prevent a 25% loss of fish population at that site is $35. If $35 is the true value for a specific site, and one could estimate the total number of fishermen using that site during a year, then one could estimate the total annual value to fishermen of the fish loss by simple multiplication ($35 x number of fishermen per year). The mean willingness-to-sell (WTS) was $386 per year. The mean WTD (additional one-way miles users were willing to drive) to get to a site with the original quality of the interview site (i.e., with the same quality the interview site had before the hypothetical 25% decrease in fish population) was 106 miles. The WTD question differs from the other contingent-valuation questions in two important ways: first, people pay for a site implicitly in miles of driving, not directly in dollars; second, the question focuses on cost or payment per trip rather than annual expenses. To convert miles-per-trip to dollars-per-year, we multiplied average one-way miles by 2 (round-trip), then by an approximate cost per mile ($.25),[1] and then by range of the

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[1] Twenty-five cents per mile approximates the compensation often paid employees for driving. Although recreation-related driving may be valued more or less than this figure, it is currently our best estimate of per-mile costs.

average number of trips per year (5-20). Using these calculations, WTD ranges between 265 and 1060 dollars per year, close to the WTS figures. If statistically valid, WTS and WTD could be used in the same way as WTP to estimate the annual value of fish lost at a given site.

Unfortunately, most of our statistical tests call into question the validity of these average figures. Although the mean response across the entire sample is large, so is the variance. The standard deviations and standard error[2] for the WTP response are 746 and 34.8, respectively, for the WTS response 9,458 and 441, and for the WTD 1,271 and 41.9. Neither the WTP responses nor the WTS responses for the whole sample were significantly different from zero. The standard deviations and standard errors are large because of the extraordinary skewness of the responses. Although most responses to all questions were similar, the top 5% were much, much higher. These extreme values had two effects. First, they substantially raised the means of the estimated values of a 25% loss in fish population. Second, they increased the variances of the estimates to such an extent that they reduce the statistical confidence we can have in any conclusions drawn from the data.

Some of the variation in the aggregate data, however, could be desirable, reflecting true differences in the quality of the eleven different sites being evaluated. Table III-1 shows the results for individual sites. Eight of the eleven sites have mean WTP responses that are significantly different from zero. The WTS answers were less consistent. The values of four sites were significantly different from zero despite the fact that the mean responses were, on average, eleven times the size of the WTP answers. Moreover, two of the four sites where the WTS answers were significant were among the three sites where the WTP responses were insignificant, evidence of inconsistency between the WTP and WTS responses. The relative rankings of the eleven sites based on WTP and WTS gives further evidence of inconsistency: site rankings differ markedly depending on which of the two variables we use for ranking.

In contrast to the WTP and WTS responses, WTD responses are significant at all eleven sites. WTD performed much more consistently than the other questions. The ranking of sites based on WTD is slightly different from WTS, although they both agree on the top four sites: Flathead Lake, Kootenai River, Bighorn River, and Swan River. In contrast, the WTP rankings are quite different from WTD.

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[2] Standard error, the standard deviation of a sampling distribution of means, is used to test whether a given sample mean is significantly different from some other value (in this case, 0). Standard error equals the standard deviation divided by the square root of the sample size.

TABLE III-1

MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]

	Willingness-to-Pay ($/Year)		Willingness-to-Sell ($/Year)		Willingness-to-Drive (Miles/Trip)	
Swan Lake	29*	(80)	241	(82)	89*	(173)
Swan River	76	(111)	580*	(72)	127*	(192)
Swan Tributaries	13	(12)	79*	(19)	53*	(33)
Bighorn River	36*	(50)	624	(51)	137*	(101)
Kootenai River	23*	(33)	1172*	(34)	154*	(67)
Lake Koocanusa	14*	(43)	196	(42)	92*	(85)
Flathead River	23*	(35)	15	(35)	85*	(70)
Flathead Lake	13*	(25)	917	(27)	178*	(52)
Hungry Horse	14	(20)	81	(20)	46*	(40)
Ashley Lake	11*	(24)	70	(22)	48*	(46)
Thompson River	11*	(43)	25*	(40)	89*	(83)
All Sites	34.5	(476)	386	(444)	106.3*	(942)

[a]Asterisks denote responses significantly different from zero (.05 significance level). Numbers in parenthesis equal number of valid observations.

Our data reflect a problem that occurs in most contingent-valuation studies: a consistent difference between WTP and WTS responses. If responses to these questions reflected true tastes, for most natural resources the WTP and WTS responses should be close to each other; the only difference between the responses should occur because in the WTS case the respondent would have slightly more income available. In fact, WTS responses exceed WTP responses by a factor of 7 to 10 in most studies which have asked both questions.[3] In this study, for every site except the Flathead River and the Thompson River, the WTS response is over six times the size of the WTP response. In the extreme case of Flathead Lake, WTS is 70 times WTP. On average, WTS is eleven times WTP.

We offer a new insight into this differential. Although the mean difference in responses is quite large between WTS and WTP, the difference is generally not statistically significant. As can be seen in Table III-2, only the Swan River and the Kootenai River have significantly different answers to the WTS and WTP questions. Although the mean WTS response is higher than the mean WTP response, people do not consistently give higher WTS than WTP answers (as Table III-6 shows, the <u>median</u> value for WTS is zero for eight of the eleven sites, which indicates that the mean WTS response is higher because it is more skewed than the WTP distribution).

To evaluate the power of the contingent-valuation approach, we perform tests on a number of hypotheses about the relative value of the sites. In Table III-3, we compare all prices of sites using each contingent-valuation measure of value. The null hypothesis is that the estimated value of declines in fish populations is the same for each pair of sites. Of the 55 possible pairs, the WTD question rejected the hypothesis of similarity 14 times (at a 5% significance level), but the WTS and WTP responses rejected the similarity of sites only 4 times each. But site comparisons using an analysis-of-variance test of whether all the sites were alike could not be rejected by the WTP or WTS responses (Table III-4). In other words, based on the contingent-valuation questions only, we have to conclude that in most cases fishermen assign equal values to potential changes in fish populations at the eleven different fishing sites. Only the WTD results could reject the hypothesis that the sites were all alike at a 5% significance level.

We also tested whether specific sites were the same as all the others. In particular, the objective characteristics of the Bighorn River suggest it is superior to the other sites in the sample. Similarly, the characteristics of the Swan River suggest that it is above average. The results of similar overall site comparisons using contingent valuation are shown in

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[3] See Schulze et. al. [1981] for a good review of recent contingent-valuation studies.

TABLE III-2

COMPARISON OF MEAN VALUES OF WILLINGNESS-TO-PAY AND WILLINGNESS-TO-SELL

	Sample Size	WTS/WTP	t-statistic[a] H_o:WTP=WTS
Swan Lake	162	8.3	1.45
Swan River	183	7.6	2.61
Swan Tributaries	31	6.1	1.39
Bighorn River	101	17.3	1.86
Kootenai River	67	50.9	2.22
Lake Koocanusa	85	14.0	1.41
Flathead River	70	0.7	.72
Flathead Lake	52	70.5	1.52
Hungry Horse	40	5.8	.90
Ashley Lake	46	6.4	1.26
Thompson River	83	2.3	1.50
	920		

[a]Hypothesis of similarity is rejected at the 5% significance level if $t > 1.96$.

TABLE III-3

TWO-WAY COMPARISONS OF SITES USING MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]
NULL HYPOTHESIS: COLUMN SITE = ROW SITE[a]

	Swan Lake	Swan River	Swan Tribu	Big-horn	Koo-tenai River	Lake Koo-canusa	Flat-head River	Flat-head Lake	Hungry Horse	Ashley Lake	Thomp-son River
WILLINGNESS-TO-PAY											
Swan Lake	X		.50		.33	.89	.32	.68		.78	1.02
Swan River	.90	X	.49	.64	.68	.92	.69	.68	.50	.70	.93
Swan Trib.			X							.30	.25
Bighorn River	.31		1.06	X	.96	1.89	.93	1.44	1.03	1.62	2.09
Kootenai River			1.23		X	1.84		1.61	1.10	2.35	2.51
Lake Koocanusa			.18			X		.14		.73	.72
Flathead River			1.04		.04	1.62	X	1.37	.93	1.88	2.15
Flathead Lake			.06					X		.50	.45
Hungry Horse	.63		.13			.04		.12	X	.55	.49
Ashley Lake										X	
Thompson River										.06	X
WILLINGNESS-TO-SELL											
Swan Lake	X					.20	.43		.46	.58	.97
Swan River	1.21	X	.52			1.20	1.55		.97	1.15	1.66
Swan Trib.			X			.56	1.90		.03	.13	1.72
Bighorn River	1.13	.11	1.01	X		1.14	1.45		.91	1.08	1.55
Kootenai River	2.20	1.22	1.51	.89	X	1.99	2.06	.26	1.36	1.61	2.22
Lake Koocanusa						X	1.19		.50	.63	1.16
Flathead River							X				
Flathead Lake	1.34	.52	1.21	.37		1.42	1.69	X	1.08	1.29	1.82
Hungry Horse							1.28		X	.13	1.17
Ashley Lake							1.24			X	1.09
Thompson River							.69				X
WILLINGNESS-TO-DRIVE											
Swan Lake	X		1.12				.16		1.45	1.54	.00
Swan River	1.57	X	1.63			1.22	1.26		1.90	2.07	1.13
Swan Trib.			X						.61	.45	.78
Bighorn River	2.11	.34	2.64	X		2.04	1.97		3.07	3.33	1.50
Kootenai River	1.67	.63	1.39	.38	X	.36	1.30		1.59	1.74	1.20
Lake Koocanusa	.14		1.90			X	.33		2.45	2.57	.10
Flathead River			1.17				X		1.56	1.63	
Flathead Lake	2.38	1.13	2.08	.97	.32	2.18	2.00	X	2.35	2.58	1.70
Hungry Horse									X		
Ashley Lake									.20	X	
Thompson River							.11		1.07	1.07	X

[a] Value reported is the t statistic. Value greater than 2.0 implies the row site is significantly more valuable than the column site at the .05 level. Each pair of sites intersects in two different cells; one has a number, the other is blank. Table arranged so that all numbers reported show the significance of the greater mean value at the row site compared to the lesser mean value at the column site.

Table III-4. None of the contingent-valuation approaches was able to differentiate significantly between the Bighorn, the Swan, and all the other sites in the sample. All these statistical tests suggest that for WTP and WTS the contingent-valuation approach has very little ability to discern between a high-quality fishing site and an average one.

TABLE III-4

OVERALL SITE COMPARISONS USING MEAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES

Hypothesis	Willingness-to-Pay	Willingness-to-Sell	Willingness-to-Drive
Bighorn River = All Other[a]	.03	.54	.74
Swan River = All Others[a]	1.23	.58	.52
Swan and Bighorn Rivers = All Others[a]	1.04	.68	.70
All Rivers Alike[b]	.54	1.68	2.15

[a]Figures reported are t-statistics. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

[b]Figure reported is an F-statistic. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

To clarify the relationship between WTP and WTS, we regressed WTP and WTS on willingness-to-drive (WTD) for the entire sample. If people tell the truth about WTP and WTS, one would expect a consistent correlation between answers to WTD, and WTP and WTS. The regression estimates how much money a mile of driving is worth. On average, users were willing to pay 15 cents per year for each additional one-way mile they were willing to drive per trip. In contrast, they were willing to sell each additional mile for $8.12. The WTP coefficient was insignificantly different from zero, suggesting the responses to WTP and WTD questions were generally inconsistent with each other. That is, a large estimate of WTP was not necessarily accompanied by a large estimate of WTD. In contrast, the WTS coefficient had a t-statistic of 6.06, suggesting that WTS and WTD responses at

least were consistent with each other. The belief, often found in the professional literature, that WTP is superior to WTS is not supported by these results.

The contingent-valuation responses measure each consumer's valuation of a major loss of fish population. This response should be closely linked with an individual's valuation of a site, which in turn is linked to his trip-demand function. Consequently, we expect that demographic or social variables that explain shifts in trip-demand functions would also be able to explain some of the variation in contingent-valuation responses across individuals. For example, men are more likely to fish than women, and families with young children might fish more frequently than families with older children. To test these hypotheses, we regressed contingent-valuation responses on the following origin-wide variables that frequently affect trip-demand functions: the percent of young people, income, median age, percent male, and relative income. (These are the variables that proved significant in the simple travel-cost regressions we ran. See Table III-7.)

Table III-5 shows the results of this multiple regression. Only relative income is significant in the willingness-to-pay equation and only the percent of males is significant in the willingness-to-sell equation. Both the percent of young people and the percent male were significantly different from zero in the willingness-to-drive equation. Thus, in the traditional WTP and WTS equations, demand-shift variables have little consistent effect on the contingent-valuation responses. Including all the explanatory variables in Table III-5 only explains from two to five percent of the variation in responses to the contingent valuation questions (i.e., the value for R^2 is less than .05). Of course, some of the remaining variation may reflect true variation in unmeasured tastes across the population. The poor quality of these results, however, also raise the possibility that there is great noise in there responses.

Examining the distribution of responses to the contingent-valuation questions more carefully, we find that the data are highly skewed, with many high-value responses. This problem plagues many contingent-valuation studies. The presence of the responses with very high values explains the large variances observed in the answers. The very high-value responses also have a disproportionate impact on the mean response in the sample. The median response to WTP questions ranges from \$3 to \$25, whereas the mean response ranges from \$11 to \$76. The median response to WTS questions ranges from \$0 to \$25, whereas the mean response range from \$15 to \$1172.

WTS and WTP mean responses are different primarily because of the responses of the top 10% of respondents. The WTS mean response is higher than the WTP mean because of the answers given by only a few respondents. Evaluated at the median (see Table III-6), the answers given by most of the sample to WTP and WTS are quite close: the much higher responses of the tail of the

TABLE III-5

MULTIPLE REGRESSION OF CONTINGENT VALUATION RESPONSES UPON DEMAND-SHIFT VARIABLES[a]

	Willingness-to-Pay ($/Year)	Willingness-to-Sell ($/Year)	Willingness-to-Drive (Miles/Trip)
% Young	-.05 (1.38)	-.03 (.42)	.08 (2.25)
Income	.00 (.84)	-.00 (1.30)	-.00 (.54)
Median Age	-.03 (.59)	-.07 (1.09)	.01 (.33)
% Male	.00 (.08)	.20 (3.32)	.14 (2.16)
Relative Income	.12 (2.24)	.09 (1.45)	.02 (.30)
Constant	3.26 (.88)	14.98 (2.29)	-6.50 (1.78)
R^2	.026	.050	.020
Number of Observations	342	280	665

[a]Figures reported are t-statistics. Values greater than 1.96 imply the hypothesis is rejected at 5% significance level.

TABLE III-6

MEDIAN VALUES OF FISHERMEN'S CONTINGENT VALUATION OF A 25% DECREASE IN FISH POPULATION IN MONTANA RIVERS AND LAKES[a]

	Willingness-to-Pay ($/Year)	Willingness-to-Sell ($/Year)	Willingness-to-Drive Miles/Trip)
Swan Lake	10	0	30
Swan River	5	10	50
Swan Tributaries	3	0	40
Bighorn River	25*	25	100*
Kootenai River	20*	25	40
Lake Koocanusa	10	0	65
Flathead River	10	0	40
Flathead Lake	5	0	85
Hungry Horse	5	0	50
Ashley Lake	10	0	30
Thompson River	5	0	25

[a]The standard deviation for the median is measured as the average difference between the first and third quartiles of the distribution. Both the median and its significance are consequently unaffected by responses on the tails of the distribution. Asterisks denote responses significantly different from zero (.05 significance level).

respondents (the upper 10%) to the WTS question causes the mean value of WTS to exceed the mean for WTP. Though the median values for WTP and WTS are close, the fact that nine of the eleven sites had a median WTS of 0 is disturbing. In other words, at over 80% of the sites, at least half of those interviewed said that they would require no compensation for a 25% loss in fish population, a result at odds with responses to the WTP and WTD results.

We can only guess at the reasons for this result. Perhaps respondents did not understand the question. Perhaps they did not feel they had any right to compensation for loss of a resource they did not feel they owned. Perhaps the response really does indicate a true value. Whatever the explanation, these results reinforce our general finding that the contingent-valuation approach is plagued by severe inconsistencies. The extreme responses by the top 5% of the sample have important policy implications. Their inclusion raises the mean but sharply lowers the consistency of the sample responses. To correct for this problem, if the top 5% of respondents are ignored, or if the mean is replaced by the median, the resulting environmental values are much lower than those generally reported in the literature on contingent-valuation.

C. Simple Travel-Cost

To estimate the demand for trips to a site, we must first compute the visitation rates. For our initial estimate of visitation rates we divided the number of observed trips from a zipcode by the population of that zipcode. This measure is biased, however, because some sites were sampled all year long (Swan drainage) while others were sampled for just a few days or weeks. To adjust for these different sampling rates, we use independent estimates of the total annual number of visitors to each site collected in a separate mail survey by the State of Montana. We then adjusted the relative visitation rates in our sample to be consistent with the relative annual visitation to the sites. For the three Swan River sites we further refined our estimates to visits by using the results of the 1984 creel survey.

We then regressed visitation rates on the price of a visit and other variables that the literature suggest could cause a demand curve to shift up or down (we call these demand-shift variables). For the price of a visit, we use the one-way distance from the origin to the destination. Multiplying this figure by the appropriate cost per mile gives travel cost. However, because the cost per mile is somewhat controversial, we make this multiplication after the regression is completed so that an interested reader could easily recalculate the resulting valuations with whatever cost per mile desired.

For demand-shift variables, we include household income, percent-of-residents-under-14, median age, and percent-male-living-in-each-zipcode. These variables are frequently used in economic literature to explain variations in taste across households for recreation and other goods. We also included relative income: the income of users sampled divided by the average income for the entire zipcode. The relative income measure captures whether users are among the poorer or wealthier members of their zipcodes. We found other variables insignificant--variables such as percent-over-65, the change of household income between 1970 and 1983, the number of persons per household, whether fishing was the sole purpose of the trip, and whether fishermen had a summer residence in the Swan drainage.

We tested three functional forms: linear, semi-log, and log-linear. Through formal goodness-of-fit tests, we determined that the log-linear model performed best. To estimate the log-linear model, we took the logs of all the independent and dependent variables. The regression model is just a linear combination of these logged values. This function form implies that a percentage change in any independent variable leads to a constant relative percentage change in the dependent variable. For example, if the coefficient on distance (price) is -.5, a 10% increase in distance leads to a 5% decrease in visits. This particular percentage-change relationship is called the price elasticity and reflects the responsiveness of quality demanded to changes in price. The price elasticity is the coefficient of the price variable in log-linear regressions. The more inelastic are prices for trips to a site, other things equal, the greater the consumer surplus or value of the site.

The results of the travel-cost model for each site are shown in Table III-7. Ten of the eleven distance coefficients had the correct sign and half were significantly different from zero. Twenty of the 55 demand-shift variable coefficients were also significantly different from zero. These results suggest a well-behaved demand function for visitation rates with consistent and relevant demand-shift effects. Interestingly enough, in 9 of the 11 sites the income elasticity is negative. That suggests that lower-income people are more likely to go fishing in Montana, holding everything else constant. Also, the greater the percent-young in a zipcode, the more likely fishing will occur. The percent-young could well be a proxy for the presence of families in this sample. The higher the median age, and the more males, the more likely people are to fish.

To determine whether the travel-cost method could differentiate across sites, we tested several hypotheses. The first hypothesis is that all the sites are alike. We ran a simple travel-cost model across the entire sample to test whether the coefficients across all sites are alike. Table III-7 shows the results. We rejected this hypothesis using a Chou test with an F

TABLE III-7

SIMPLE TRAVEL-COST REGRESSIONS, BY SITE[a]

Site	Constant	Distance (Miles)	Income ($/Year)	% Young (>14 yrs)	Median Age (Years)	% Male	Relative Income[b]
Swan Lake	-28 (4.15)	-.48 (5.35)	-2.23 (3.79)	4.14 (3.41)	5.88 (4.26)	18.66 (3.80)	-.56 (2.42)
Swan River	-36 (1.06)	-.48 (3.35)	-2.01 (3.06)	1.17 (1.98)	3.20 (1.87)	6.84 (1.14)	-.50 (1.97)
Swan Tributaries	-83 (.94)	.01 (.02)	-3.17 (.64)	-.24 (.02)	8.95 (.63)	35.2 (1.48)	.46 (.34)
Bighorn River	-83 (6.74)	-.39 (1.97)	-.89 (1.05)	6.28 (3.64)	8.58 (3.88)	26.1 (4.61)	.57 (1.56)
Kootenai River	-63 (2.10)	-.11 (.57)	-2.93 (2.45)	2.79 (1.75)	6.25 (2.00)	30.38 (2.23)	.59 (1.06)
Lake Koocanusa	-24 (2.74)	-.26 (4.88)	-1.95 (2.20)	4.98 (2.51)	5.25 (2.01)	17.23 (2.21)	-.08 (.23)
Flathead River	-34 (.44)	-.60 (3.38)	-1.22 (.89)	2.03 (.78)	4.29 (1.19)	4.28 (.23)	.29 (.73)
Flathead Lake	-126 (2.42)	-.33 (2.44)	-.07 (.04)	9.11 (1.66)	16.75 (3.21)	25.49 (1.47)	.41 (.88)
Hungry Horse	-53 (.14)	-.69 (1.88)	4.47 (1.25)	1.19 (.62)	1.15 (.20)	-11.96 (.57)	.45 (.59)
Ashley Lake	-28 (.86)	-.18 (.85)	1.75 (.54)	-2.49 (.33)	4.26 (.36)	15.5 (.96)	-1.13 (1.55)
Thompson River	-12 (2.45)	-.64 (3.36)	-.63 (.68)	.19 (.14)	2.21 (1.03)	17.36 (2.32)	.44 (1.17)
All Sites	-13 (5.06)	-.54 (8.98)	-2.01 (5.00)	2.34 (4.88)	4.65 (4.61)	17.36 (5.14)	-.08 (.54)

[a]The dependent variable is the log of visitation rates. The functional form for this regression is log-linear. The t-statistics are in parentheses.

[b]Relative income is the average sample family income divided by the zipcode family income.

statistic of 29.05. When all sites are treated alike, the additional distance and income tend to reduce visitation rates, whereas more children, higher median age, and more males all increase visitation rates across zipcodes.

In our second series of tests, we examined whether the demand for trips to all sites were alike except for the intercept of the demand curve. We expect more valuable sites to have higher demand curves, less valuable sites lower demand curves. We assumed that the slopes of the curves and the effects of demand-shift variable would be alike for both high- and low-value sites. We ran the travel-cost regression across all observations adding a dummy variable for all but one site. The dummy variable takes the value of "1" if the observation is from that site and "0" otherwise. The coefficient on the dummy variable reflects whether the demand for that site is higher (positive) or lower (negative) than the demand for the omitted site holding all other factors constant. Presumably, sites with better fishing opportunities would have relatively higher demand curves for visits.

Table III-8 shows the results of these analyses. In the first regression, a dummy variable was included for all sites except the Kootenai River. (The selection of the Kootenai is arbitary. The point in this analysis is to rank ten of our sites relative to the eleventh.) The coefficient on each of these dummy variables reflects the number of visits a person would make to that site compared to the Kootenai, assuming all sites are equidistant. Three of the sites have significantly higher demand curves than the Kootenai: Bighorn River, Flathead River, and Flathead Lake. Four of the sites have significantly lower demand curves than the Kootenai: Swan Tributaries, Swan Lake, Swan River, and the Thompson River. The remaining sites would be visited about as often as the Kootenai. These results suggest that the eleven sites can be broken down roughly into three categories of quality: high, medium, and low.

The second regression in Table III-8 takes advantage of this grouping by leaving out all the medium-quality sites. The dummy variable coefficients consequently reflect how an individual site compares to the group of medium sites. Flathead Lake is the most highly valued site, with the Bighorn River a very close second. The Flathead River is a more distant third. On the other side of the ledger, the Swan River is ninth of the eleven sites. Swan Lake is tenth, and the Swan Tributaries a distant last.

The third regression in Table III-8 explores the possibility that the slopes as well as the intercepts of the visit demand functions might vary across sites. A dummy variable for the price slope (distance times the 1,0 dummy variable for the site) of each site is included in the regression. The slope of the demand curve is important because the value of the site is equal to the area under the demand curve. If a demand-for-visits curve is very flat, it implies that people have close substitutes for trips to that site: if the site visit gets even a little more expensive, people would stop going to the site altogether. Such

TABLE III-8

SIMPLE TRAVEL-COST REGRESSIONS, MULTIPLE SITES[a]

Regression Number:	1	2	3
INDEPENDENT VARIABLES			
Constant	-31.2	-30.3	-28.0
	(8.49)	(8.42)	(7.88)
Distance	-.35	-.35	-.29
	(7.61)	(7.57)	(3.82)
Income	-1.81	-1.87	-1.95
	(6.26)	(6.55)	(6.45)
Children	2.21	2.23	2.23
	(6.42)	(6.57)	(6.22)
Median Age	4.39	4.39	4.53
	(6.10)	(6.18)	(6.09)
% Male	20.6	20.6	20.0
	(8.64)	(8.63)	(7.96)
Relative Income	-.04	-.06	-.07
	(.39)	(.52)	(.58)
SHIFT DUMMIES			
Bighorn River	1.31	1.08	3.37
	(4.27)	(4.46)	(3.21)
Flathead River	.82	.59	1.51
	(2.30)	(1.95)	(2.66)
Flathead Lake	1.45	1.22	1.81
	(4.06)	(4.10)	(2.04)
Swan River	-1.34	-1.56	-.63
	(4.84)	(7.56)	(.81)
Swan Lake	-1.85	-2.10	-.81
	(6.67)	(10.38)	(1.10)
Swan Tributaries	-3.22	-3.46	-3.87
	(7.66)	(9.26)	(3.16)
Thompson River	-.97	-1.21	--
	(3.24)	(5.22)	--
Hungry Horse	.53	--	--
	(1.26)	--	--
Lake Koocanusa	.41	--	--
	(1.34)	--	--
Ashley Lake	-.02	--	--
	(.06)	--	--

[a]The dependent variable is the log of visitation rates. The functional form is log-linear and the t-statistics are in parentheses. These regressions were performed across eleven sites.

TABLE III-8-Continued

SIMPLE TRAVEL-COST REGRESSIONS, MULTIPLE SITES[a]

SLOPE DUMMIES			
Bighorn River	--	--	-.36
	--	--	(1.88)
Flathead River	--	--	-.18
	--	--	(1.04)
Flathead Lake	--	--	.06
	--	--	(.44)
Swan River	--	--	-.17
			(1.27)
Swan Lake	--	--	.11
	--	--	(.78)
Swan Tributaries	--	--	.16
	--	--	(.45)
R^2	.74	.73	.72
Sum of Squared Residuals	425	429	456

[a]The dependent variable is the log of visitation rates. The functional form is log-linear and the t-statistics are in parentheses. These regressions were performed across eleven sites.

a site, therefore, has little net value. In contrast, if the slope of a site visit demand function was very steep, it implies users feel the site is unique: although with greater expense they do reduce visits, it is difficult for them to find close substitutes so they reduce visits very slowly. In other words, they are willing to pay a great deal for access to the site, especially as the total number of trips is reduced. Sites with relatively steeper slopes, all other things equal, are consequently more valuable.

The third regression implies that the slope coefficients are in fact similar across sites. None of the dummy variables for slope coefficients are significantly different from zero. That is, the data are unable to find a difference in the slopes across sites. We assume that the slopes of the demand functions are the same for all sites.

We also tested whether the coefficients for the demand-shift variables were significantly different across sites. We examined the null hypothesis that the second regression in Table III-8, which captures just the intercept effects, was different from the 11 individual regressions in Table III-7, which capture all differences across sites. We could not reject the null hypothesis, which suggests that the demand-shift effects were indeed similar across sites. The second regression in Table III-8 is our best model for these data; it explains all significant variations across sites with the fewest coefficients.

In a final set of tests, we performed a series of pairwise comparisons among sites similar to those we performed for contingent-valuation-responses in Table III-3. We analyzed every combination of sites, assigning a dummy variable to one site of the pair, to test which had a higher demand curve for visits. If the dummy for site A were positive when compared with site B, then site A would be a better quality site than B. If the dummy were also significant, then the difference in quality is also significant. Table III-9 shows the t-statistics of the dummy variable. A t-statistic greater than 2.0 implies a significant difference. Of the 55 comparisons, 40 were significant. Compared to the contingent-valuation method the travel-cost method was able to make sharper distinctions about the quality of sites. The same water bodies identified as high quality in Table III-8 are found valuable in Table III-9: Flathead Lake, Bighorn River, and Flathead River. Similarly, the lowest quality sites, the Swan drainage and the Thompson River are given low ratings by both methods of comparisons using travel cost. The pairwise comparisons confirm the results found in the overall site analysis.

TABLE III-9

TWO-WAY COMPARISONS OF SITES USING TRAVEL-COST METHOD[a]
NULL HYPOTHESIS: COLUMN SITE = ROW SITE

	Swan Lake	Swan River	Swan Tribu	Big-horn	Koo-tenai River	Lake Koo-canusa	Flat-head River	Flat-head Lake	Hungry Horse	Ashley Lake	Thomp-son River
Swan Lake			4.59								
Swan River	2.24		4.64								
Swan Trib.											
Bighorn River	14.35	9.03	11.18		2.91	3.39	0.30		0.99	3.29	7.51
Kootenai River	6.72	3.91	6.74								2.72
Lake Koocanusa	9.06	5.86	9.32		0.71					0.71	5.48
Flathead River	8.38	5.01	10.09		2.64	1.72			0.98	2.07	6.15
Flathead Lake	9.26	6.02	7.71	0.36	2.94	3.21	0.63		0.94	3.45	5.47
Hungry Horse	5.36	3.26	7.15		1.46	0.03				0.41	3.64
Ashley Lake	4.91	3.02	6.07		0.01						2.77
Thompson River	3.45	1.01	6.30								

[a] A row site is superior to a column site if there is a number in the row associated with that column. The figure shown is the T-statistic.

D. Hedonic Travel Cost

Although the simple travel-cost technique was able to differentiate high-quality from average sites, it could not estimate the value of individual characteristics of sites. At its best, the simple travel-cost technique can estimate total value of a recreation site in all uses; it cannot estimate, for example, the separate value of fishing or beautiful scenery. The hedonic travel-cost method, however, values the individual characteristics of sites.

Estimating the value of these characteristics involves two sets of calculations. In the first stage, we estimate the value by regressing, for each origin, travel cost on the characteristics of the sites visited. The coefficients of the independent variables (the site characteristics) tell us how much the dependent variable (travel cost) changes when the characteristics change. In other words, the coefficients may be interpreted as the values, or prices, of the characteristics.

For each respondent, we use data he provided about the three fishing sites he said he most frequently visited during the previous year. We perform this regression independently for each origin, that is, we estimate the average value of a unit of each characteristic at each origin. The characteristics we looked at (our independent variables) were catch rate (number of fish caught per day), average size of largest fish in catch (in inches), scenery, percent trout-as-primary-species, percent bull-trout-primary-species, river, man-made lake, and managed-as-a-trout-water-body. We use a linear functional form in these price regressions, implying a constant marginal price for each characteristic. For example, residents from Missoula are willing to travel, on average, an extra 5.6 miles for an extra inch in the size of fish they catch. The linear functional form suggests that an extra inch costs Missoula residents 5.6 miles, whether they want 10 inch or 16 inch fish.

The second stage of the technique involves estimating the demand function for the characteristic, which shows what users are willing to pay for each level of the characteristic. We regress the marginal price of each characteristic (the price coefficient from the first-stage regression) on the levels of characteristics and a set of demand-shift variables.

In the first stage, we regress travel cost on the observable characteristics of sites: catch per day, size of largest fish caught, trout or not, bull trout or not, management designation, and scenery. To determine which of these variables contribute to site quality, we must have many trips from a single origin. But when data are collected by site instead of by origin, it is difficult to get adequate samples from specific origins. By combining zipcode areas around certain cities, we were able to identify thirteen origins with sufficient data to perform price regressions. Table III-10 shows the thirteen cities. All of the out-of-state price regressions were insignificantly different from zero. The poor performance of these more-distant users can probably be explained by their small numbers (from a specific origin), the fact that they are more likely to be on a multiple-purpose trip, and our relatively poorer measurements of their next best alternative sites.

After omitting sites, we have only 504 observations in the sample for the hedonic travel-cost analysis. When all the variables are included in the regression, the management designation --whether the river body is a river, lake, or manmade lake or trout managed--and scenery were insignificant. That is not to say that users do not care whether the sites are in the scenic Rocky Mountains or not. Rather, the results suggest that users do not care about the observable variation in scenery among sites in Western Montana. Similarly, fishermen do not care whether they fish on natural or manmade lakes or rivers as long as the fishing is equally good. It is the fishing that matters, not the water body.

A similar inference can be made about management designations. The fact that rivers may be designated for trout does not matter to the fisherman. What matters is the quality of the fishing. Consequently, the benefits of the management programs can be measured precisely by their impact on the actual fishing.

Because of their lack of significance, we dropped management designations and scenery from the regressions. Table III-10 shows the remaining hedonic price regressions for each of the thirteen origins. Note that although each characteristic is

TABLE III-10

HEDONIC PRICE REGRESSIONS[a]

Zip Code Origin	Constant	Catch (fish per day)	Size of largest fish caught (inches)	Trout (dummy)	Bull Trout (dummy)	R^2
Billings	203.0*	-.58	1.14	-126.0*	1967*	.23
Great Falls	-70.8	14.8*	1.6	72.4*	838*	.54
Conrad, Shelby	206.0*	-15.0*	-6.5	72.4*	1391*	.92
Havre	38.0	-36.0	6.4	141.0	2818*	.41
Helena	-62.0*	5.0*	-.29	93.0*	1464*	.80
Butte	-192.0	-.8	4.3	191.0	4098*	.42
Missoula	-18.0	.38	5.6*	16.5	7.5	.12
Charlo	-123.0*	10.0*	6.1*	52.0*	-211	.46
Kalispell	-48.0*	.04	4.7*	52.0*	-386*	.21
Big Fork	-112.0*	3.6*	5.9*	56.8*	-230*	.27
Columbia Falls	6.0	1.1	1.2	20.8	-268*	.18
Whitefish	0.2	4.1	0.1	68.0*	-342	.13
Libby	130.0*	-2.0	-2.7	57.0*	634	.25

[a]Linear regressions with one-way distance in miles as a dependent variable. Coefficients shown are the additional miles traveled to get another unit of a characteristic. Asterisks denote responses significantly different from zero (.05 significance level).

significant in several regressions, many variables have negative coefficients. In each of there origins, the negative coefficients suggest people travel further to avoid these characteristics. Although it is possible each of these characteristics might be deemed undesirable, the negative coefficients probably either reflect measurement problems (noise), omitted variables (bias), or the small sample. In general, the negative coefficients, especially if significant, add some uncertainty to our final estimates of value.

In the second stage, we combined the 504 observations from the thirteen origins to calculate the demand for each characteristic. Table III-11 shows the results, many of which are promising. The own-price coefficient (that is, the effect of changes in the price of a characteristic on that characteristic) for all four attributes is negative as expected. For example, the amount a fisherman will pay to catch a fish one inch longer declines by 50% for each inch of fish already caught. The demand function for these attributes slopes downward. The own-price coefficient is significantly different from zero for both the size of fish and whether trout is the target species. There are also significant interactions among the characteristics. Fishermen targeting trout are willing to pay less for both the number and size of catch. The bigger the size of catch, the more fishermen will pay for more frequent catch. Finally, if trout are the target species, fishermen are willing to pay more for bull trout.

TABLE III-11

DEMAND FOR FISHING SITE CHARACTERISTICS[a]

Dependent Variable	Constant	Catch (per day)	Size (inches)	Trout (dummy)	Bulltrout (dummy)	R^2
Price of Catch	.86	-.007	.08*	-1.72*	-.25	.03
Price of Size	4.72*	.04*	-.05*	1.42*	3.01*	.06
Price of Trout	62.1*	1.56*	-1.2*	-42.7*	24.2	.09
Price of Bulltrout	-391*	-15.7*	12.2	746*	-564	.11

[a]Linear regression with coefficients shown and significance from zero at .05 level of significance marked by an asterisk. All prices are measured in miles per unit.

On the other hand, Table III-11 is not an unmitigated success. The equations were unable to explain much of the observed variation in hedonic prices. This may reflect measurement problems with the prices themselves, omitted characteristics of sites, or the absence of important variables which explain people's preferences for site qualities.

Catch rates, size, and targeting bull trout are all characteristics with elastic demand functions near the mean of the sample. That is, what fishermen are willing to pay for a little more of each of these characteristics does not change very much with the level of characteristics purchased. The price of these charactertistics can be used as a reasonable approximation of the average value of the characteristic across a broad range of values.

Targeting trout appears to have a unitary price elasticity. That is, for each 10% increase in trout fishing there is a 10% decline in the marginal willingness-to-pay. Suppose at the mean of the sample, fishermen are willing to pay $10 per trip to target trout. A 25% decline in the frequency of trout fishing would, therefore, increase the value of targeting trout by $2.50 per trip to $12.50.

IV. CONCLUSION

In this study, we used three different methods to analyze the value of fish in Montana. We had two goals. First, we wanted to evaluate the methods to determine which are most useful. Second, we hoped to provide useable estimates of the value of fish lost from hydroelectric development in the Swan drainage.

We discuss the results of the methodological comparison first. We used both the travel-cost and contingent-valuation questions to rank the sites (Table IV-1). The rankings are clearly not uniform across the techniques. The only water body consistently rated by all four methodologies is the Swan Tributaries, which clearly is of relatively lower quality than the other sites we sampled.

TABLE IV-1

RELATIVE RANKINGS OF SITES

RELATIVE QUALITY	METHOD USED FOR MEASURING QUALITY			
	CONTINGENT VALUATION			REVEALED PREFERENCE
	WTP	WTS	WTD	Travel Cost
HIGHER QUALITY	Swan River	Kootenai Flathead Lake	Flathead Lake Kootenai Bighorn Swan River	Flathead Lake Bighorn Flathead River
MEDIUM QUALITY	Bighorn Swan Lake Kootenai Flathead River	Bighorn Swan River Swan Lake Koocanusa	Koocanusa Swan Lake Thompson Flathead River	Hungry Horse Koocanusa Kootenai Ashley
LOWER QUALITY	Koocanusa Hungry Horse Flathead Lake Swan Trib. Ashley Thompson	Hungry Horse Swan Trib. Ashley Thompson Flathead River	Swan Trib. Ashley Hungry Horse	Thompson Swan River Swan Lake Swan Trib.

Rankings based on willingness-to-pay are the most different from all the others. None of the water bodies identified by the travel-cost method as higher-quality is ranked as higher-quality by the WTP responses. The Swan River, ranked by travel-cost as lower-quality, is ranked first by the WTP response. The WTP response also differs from the WTS and WTD rankings. For

example, both the Kootenai River and Flathead Lake are ranked in the top group by WTD and WTS. The WTP ranking puts them in the middle and bottom, respectively.

The WTS and WTD responses are somewhat closer to each other. For example, both the Kootenai River and Flathead Lake are ranked higher-quality by both methods. However, WTD also recognizes the Bighorn River and Swan River as top sites, whereas WTS ranks them as medium. Both WTS and WTD recognized the value of Flathead Lake, but only WTD ranked the Bighorn as highly as travel-cost method did.

The focus of this study is on the Swan River drainage. Note that all the contingent-valuation measures ranked Swan River and Swan Lake more highly than the travel-cost method did. It is indeed possible that contingent-valuation surveys, which focus on one site at a time, over-value that site relative to alternative sites. That is, once a policy question arises such as whether to dam a particular river, contingent-valuation surveys focused on that river may overestimate its value. This direction of bias seems theoretically more likely than the alternative: that people generally overstate their preferences for a site, but tend to express true values when that site is threatened. To avoid this bias using contingent valuation, it may be necessary to value the sites in a system prior to the time a policy issue attracts public attention to a specific site.

In addition to just ranking the sites, we also compared the internal consistency or hypothesis-testing ability of each approach (Table IV-2). Obviously, one would like a technique that

TABLE IV-2

STATISTICAL POWER OF APPROACHES[a]

Null Hypothesis	--Contingent Valuation--			Revealed Preference:
	WTP	WTS	WTD	Travel Cost
Value of sites are zero	8	4	11	10
Pairwise sites are alike	4	3	14	40
Sites equal to the average	0	0	3	7

[a]The figures represent the number of sites where the responses could reject the null hypothesis with a 5% significance level. The higher the numbers, the better able the technique to draw distinctions among sites.

is not only unbiased but also accurate. In this respect, we found the responses to each approach varied a great deal. Whereas all the approaches value fish highly, the contingent-valuation estimates tend to have wide variances. This problem is especially evident with the willingness-to-pay and the willingness-to-sell approaches. Despite an average valuation for all sites of $386 per year for a 25% fish loss, only four of the eleven responses to WTS were statistically different from zero. When comparing each site to all others, we found only three pairs were significantly different using WTS, despite the research plan to provide a distribution of different quality sites. The WTP pairwise comparisons were only slightly better with four distinct pairs. In contrast, willingness-to-drive responses could identify 14 distinct pairs, and travel-cost identified 40 distinct pairs. Further, the WTP and WTS approaches were unable to distinguish any site from the group average. The WTD responses were slightly more powerful, picking out three sites as below average. In contrast, the travel-cost method identified seven sites as being different from the average. The contingent-valuation methods suffered from a high degree of noise or random responses, especially when using the willingness-to-pay and willingness-to-sell responses.

The contingent-valuation method suggests that fishermen care about reduction of fish at all the sites they visit. The contingent-valuation method, however, could not distinguish between the species of fish, the number of fish, or the size of fish. That is, despite the fact that these variables vary over all eleven sites, the contingent-valuation method valued a 25% loss of the existing fish population equally at each site. In contrast, the hedonic travel-cost method suggests that fishermen care a great deal about species, especially trout and bull trout, and to a lesser extent about size and catch per day. Thus, the loss of 25% of a fish population in general is not worth a great deal to fishermen. However, the loss of an opportunity to fish for trout or bull trout _is_ worth a great deal. The policy implications of the results of the contingent-valuation and hedonic travel-cost methods are consequently quite different.

Because we asked all individuals two contingent-valuation questions, we can make a final check for consistency by comparing individual responses to both questions. In the half of the sample asked willingness-to-sell questions, we found that people who value fishing highly with WTS also value fishing highly with willingness-to-drive. The two approaches are consistent across individuals. In contrast, we found that people who value fishing highly when asked willingness-to-pay questions did not necessarily value that same fishing highly with the WTD question. The individual's valuation of the same river seemed to change depending upon whether she was asked about WTP or WTD. People are clearly not interpreting these questions as purely valuation issues or the responses would have been closely correlated. Exactly how people are truly interpreting and responding to these questions is difficult to know, which makes it difficult to correct for these hidden influences. Identifying and mitigating

these invisible but disconcerting influences is the challenge facing practitioners of the contingent-valuation method.

The second major goal of our study was to arrive at concrete estimates of the value of fish loss in the Swan drainage. The travel-cost method provides an upper limit to the value of this loss because it measures the total value of the sites to fishermen who use them. At worst, the loss of some fish would be equivalent to the loss of the site altogether. More likely, the loss of some fish will only decrease the value of the site to fishermen, not make it worthless. The travel-cost procedure we follow provides an estimate of this upper limit. It could be repeated for any of the eleven sites in Table III-8. To extrapolate to yet other sites, it would be necessary to compute the parameters of the visitation demand function shown in Table III-8 for those other sites.

Our calculations require two important assumptions. First, we assume travel costs per mile, including travel time, are $.25 per traveled mile, or $.50 per one-way mile. To convert distance in one-way miles to travel cost, we use $.25 as an estimate of total cost per mile. This total cost includes part of out-of-pocket costs, fixed transportation costs (insurance, license, etc.), and travel time. All out-of-pocket costs should probably be included. Fixed costs, however, are more controversial. Whereas the State of Montana may pay $.23 per mile to include all of fixed costs, it is not clear that recreationists actually value miles at such a high rate. Similarly, although people could value their time at their marginal wage rate, they tend to behave as though their time is worth only a fraction of wages. Commuters tend to value their time at 1/3 of their wage. Recreationists, who probably travel on more beautiful roads, may put a net value on their time even lower than the commuters. The reader who finds $.25 per mile too low can adjust our travel-cost estimates in proportion to his or her estimate of travel cost per mile. For example, if travel cost per mile is really $.50 not $.25, then the estimates of site value would double. Our estimates of site value will change in direct proportion to changes in assumptions about the cost per mile of travel.

Our second important assumption is that the effects of nearby substitutes for the measured site are the same regardless of the distance from the origin to the destination. In order to take account of the complex interactions amongst sites, we would need more data about user choices in Montana.

To calculate the total value of a water body, we do not have to keep track of the individual variation in the demand for sites: the difference between what rich and poor people would pay for use of the site. We consequently can evaluate the visitation demand curve using the mean characteristics of the sample. By multiplying the coefficients of each demographic variable by the mean value, the effects of these demand shift variables can be folded into the constant term. Using the second regression in Table III-8, we make the following calculation for income,

children, median age, percent male, and relative income: ((-1.87 * 10.22) + (2.23 * 3.17) + (4.39 * 3.41) + (20.6 * 1.64) + (-.06 * .26) = 36.70). Adding this value (36.70) to the constant term -30.3 in Table III-8 gives us a new constant 6.37. We can now write a simplified equation for the <u>average</u> demand function for all eleven sites:

$$\ln V = 6.37 - .35 \ln X$$

where V is the annual number of visits to the site and X is the distance from the site.

To get a visitation demand function for a specific site, we adjust the average demand curve up or down by adding the demand-shift dummy variable for that site to the constant (6.37). Above-average sites will have a positive dummy variable, which will increase the constant and, thus, the visitation rate at all distances. For example, the dummy variable for Swan River is -1.56, which means that Swan River is less valuable (will generate fewer visits) than the medium-quality sites to which the second regression equation compares it (Kootenai, Hungry Horse, Koocanusa, and Ashley). Adding -1.56 to 6.37 gives the following visitation equation for Swan River:

$$\ln V = 4.81 - .35 \ln X$$

We can further simplify this equation by raising both sides of it to the exponential form, giving us:

$$V = e^{4.81} (X^{-.35})$$

We show similar equations for each of the eleven sites in Table IV-3. They describe the aggregate annual trips to each site for each distance. In other words, they show the rate of annual visits per mile. To compute the <u>net</u> value of each site from each distance, we calculate the area under the demand curve and above the cost of a trip from that distance (see Figure IV-1). This gives us a measure of consumer surplus for all people making visits from a particular distance. For example, for all the people who live 30 miles from the Swan River, the net value they collectively place on the Swan River is:

$$\text{Net Value} = \int_{30}^{300} \text{Visits } dX$$

$$= \int_{30}^{300} (e^{4.81}) * (X^{-.35})\, dX$$

$$= \frac{e^{4.81}}{.65} * (X^{.65}) \Big]_{30}^{300}$$

$$= 5978 \text{ miles}$$

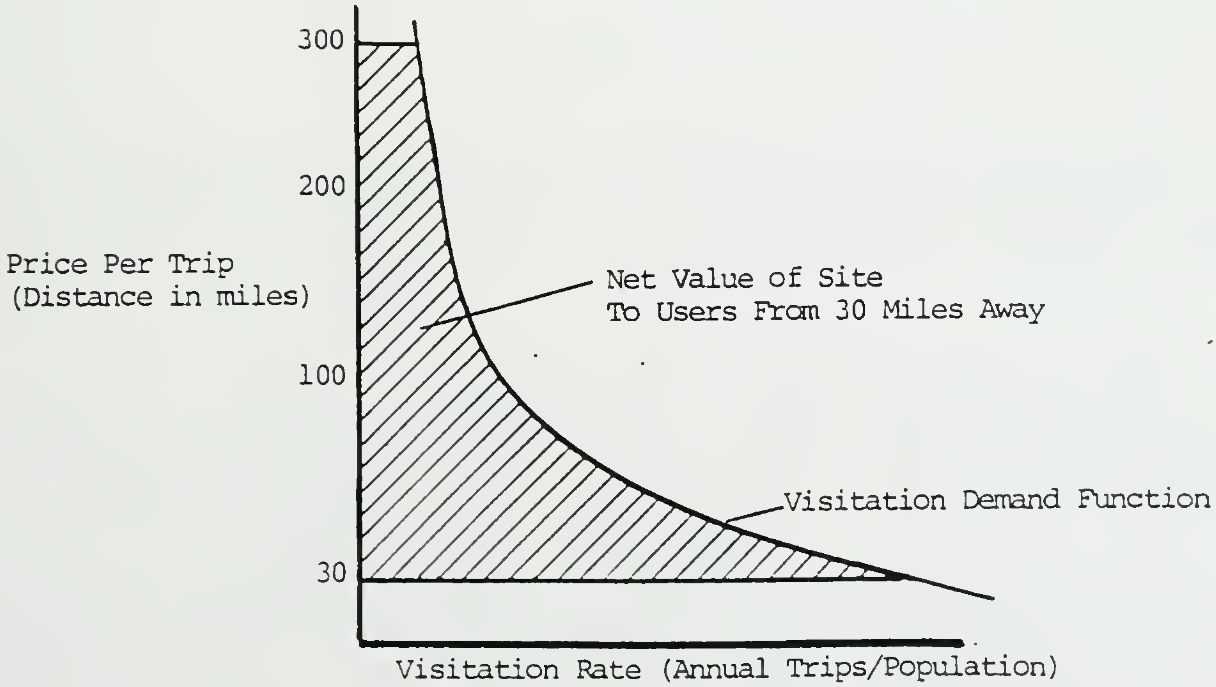
TABLE IV-3

ANNUAL VISITATION DEMAND AS A FUNCTION OF DISTANCE FROM THE SITE[a]

Swan Lake	$V = e^{4.27} (X^{-.35})$
Swan River	$V = e^{4.81} (X^{-.35})$
Swan Tributaries	$V = e^{2.91} (X^{-.35})$
Bighorn River	$V = e^{7.45} (X^{-.35})$
Flathead Lake	$V = e^{7.59} (X^{-.35})$
Flathead River	$V = e^{6.96} (X^{-.35})$
Thompson River	$V = e^{5.16} (X^{-.35})$
Hungry Horse, Kootenai River, Lake Koocanusa, and Ashley Lake	$V = e^{6.37} (X^{-.35})$

[a]These functions were computed from the second regression in Table III-8 evaluated at the mean of the demand shift variables. V is annual visits and X is distance from the site.

Figure IV-1
Consumer Surplus Value of Site



We somewhat arbitrarily cutoff the integral at 300 miles because very few people from beyond that distance are observed to visit the Swan drainage. To extrapolate the log-linear functional form beyond 300 miles seems inappropriate. To convert from one-way miles to dollars we simple multiply by \$.50/mile, yielding \$2,989 per year.

The previous equation gives us the value of consumer surplus (measured in miles, which we then convert to dollars) for all individuals <u>at a particular distance</u>. But we want to know the total consumer surplus, the sum of the surpluses for all individuals at all distances. We must sum the net value at each distance along the aggregate visitation function to estimate the total net value of the water body. In general, this requires a second integration, covering all distances between 0 and 300 miles. If a is the constant in the equations in Table IV-3, and b is the coefficient on distance (-.35 for all sites we studied), then for each travel-cost function, the total value (TV, measured in one-way miles) is:

$$TV = \int_0^{300} \int_y^{300} (e^a) * (X^{-b})\, dX\, dy$$

$$= \frac{e^a}{1-b} * \int_0^{300} \left(300^{(1-b)} - y^{(1-b)}\right) dy$$

$$= \frac{e^a}{1-b} * \left(300^{(2-b)} - \frac{300^{(2-b)}}{2-b} \right)$$

$$= \frac{e^a}{2-b} * 300^{(2-b)}$$

Substituting the appropriate parameters a and b from Table IV-3 into the above equation yields the following estimates for Swan Lake, River, and Tributaries respectively: 530,000, 909,000, and 136,000 in miles. Multiplying by \$.50 per one-way mile gives the following annual dollar value for Swan Lake, River, and Tributaries: \$265,000, \$455,000, and \$68,000.

Let us compare these simple travel-cost estimates of the total value of each of these sites with the contingent-valuation estimate of a 25% loss of fish at each site. The total willingness-to-pay to avoid these losses is simply the mean value per fisherman times the number of fishermen. We must be careful to count each fisherman only once, despite the fact that he or she may make several trips. MDFWP has good estimates of fisherman-hours per year and of average fisherman-hours per day; together these data provide an estimate of the annual number of fishermen-days. Since the data in our survey aims primarily at fishing <u>parties</u> rather than <u>individual</u> fishermen, we must make some assumptions to convert it. We know the average number of

fishermen per party, by site. Thus, we can convert annual fishermen-days to annual party-days, a variable for which we have accurate data from the creel census. To simplify our calculations we make a what seems a reasonable guess that the average number of annual visits made by a fisherman is between two and three, which is approximately the average number of fishermen per party. This simplification allows us to use our data on the number of annual party-days as an approximation of the annual number of individual fishermen who visit a site, without double-counting repeat visits.

We admit the calculation is crude and convoluted. A preferable method would be to convert fisherman-days per year directly to fishermen by dividing by the number of days per year that the average fisherman fished. Unfortunately, we have no estimate of that number. That number could probably be calculated from data collected in the survey, but that calculation would require additional assumptions and more time than we had available.

If we take annual party-days as an approximation of the number of individual fishermen who visit a site annually, then from the 1984 creel census, the total number of fishermen would then be 3,733, 2,693, and 1,405 for Swan Lake, River, and Tributaries respectively. For WTP and WTS the total value of a 25% decrease in fish density is the product of these figures times the mean figures shown in Table III-1. The results are shown in Table IV-4. The estimates of WTD per trip must first be converted to dollars ($.50/per one-way mile) and then multiplied by

TABLE IV-4
AGGREGATE VALUATION OF A 25% FISH LOSS BY METHOD[a]
DOLLARS/YEAR

	---Contingent Valuation---			---Revealed Preference---	
	WTP	WTS	WTD	Travel-Cost[b]	Hedonic Travel-Cost
Swan Lake	108,260	899,650	110,750	265,000	58,350
Swan River	204,670	1,561,940	113,980	455,000	42,080
Swan Trib.	18,270	111,000	24,820	68,000	21,960
TOTAL	331,200	2,562,590	249,550	788,000	122,390

[a] All of these estimates are contingent on the uncertain total visits and total number of fishermen at each site per year. See the text for a discussion of the statistical reliability of each estimate.

[b] The travel-cost method estimates the value of a 25% loss of the <u>site</u> to fishermen, not just the value to them of a 25% loss of <u>fish</u>.

the total number of trips. We calculate total trips (visits) by dividing the estimates provided by MDFWP on the number of days parties of fishermen fished per year by the number of days spent per visit by each party (1.5). For example, at Swan River, there were 16,500 hours of fishing per year. Fishermen spent an average of 2.76 hours per day fishing, there were 2.22 fishermen per party at the River, and each party fished 1.5 days per visit. Multiplying all these factors together yields a single factor of 9.1908 which we can divide into total fishing hours (16,500) to get total trips (visits) by parties (1,795). Total trips times WTD (in Table III-1), times $.50/mile, yields our estimate of value.

Finally, we can calculate value of a 25% fish loss using hedonic travel-cost method. From Table III-10 we can calculate the average value of a party-visit, by target species. For example, for bull trout we sum the bull trout dummy variable coefficients for all zipcode origins and divide by the number of origins (13) to get an average value of targeting bull trout of 906, which represents the additional miles a party would travel to get another unit of bull trout. (Because of the wide variation among the coefficients, this average is uncertain; the standard deviation is about 1,400.) As before, we convert one-way miles to travel cost by multiplying by $.50/mile, yielding approximately $450, the price of targeting bull trout per party-visit. Similar calculations yield a price of about $30 for targeting trout per party-visit. We know the number of annual party-visits at Swan Lake, River, and Tributaries. MDFWP have calculated the percentage of all trips that target bull trout at each site: 16.4%, 6%, and 0% respectively. At all three sites, about 66.6% of the party visits targeted trout. To calculate the value of the number of visits that would be lost by a 25% reduction in fish of all species, we multiply total party-visits by the target species percentage, by 25%, by the value of a targeted visit, for both bull trout and trout. For example, for Swan Lake:

Value of 25% Fish Loss = 2,489 party-visits/year

x 25% fish loss

x ((16.4% x $450)+(66.6% x$30)
Value of lost bull trout and
trout visits

= $58,355

Let us compare the results in Table IV-4. The travel-cost estimates are a measure of the total value of the site to fisherman, not just a 25% loss in fish. Consequently, they should be viewed as an upper bound on the value of the fish loss to fishermen. The willingness-to-sell responses exceed this upper bound, suggesting these responses are biased upwards. The remaining

estimates all fall below the travel-cost estimate as expected. The willingness-to-pay responses, although below travel-cost estimates, are 25% above the willingness-to-drive and 60% above the hedonic travel-cost measures on average. The willingness-to-drive and the hedonic travel-cost measures have surprisingly good correlation. It may well be that people can give clearer responses to how many miles they would have to drive rather than how many dollars they would be willing to pay for an environmental amenity.

Our research contains two important policy results. First, dollar-oriented contingent-valuation questions provide unreliable measures of the value of recreation sites. Second, simple travel-cost, travel-oriented contingent-valuation, and the hedonic travel cost methods yield consistent and significant measures of the value of recreation sites. For these revealed preference techniques to be more useful for policy purposes, however, additional research is needed. To better understand the tradeoffs users make in choosing sites, more sites need to be surveyed. The additional sites and additional observations permit a deeper understanding of the natural characterisitcs users value and also a better understanding of the impact of fishing regulations. For example, with more sites and more observations, it will be possible to collect more accurate estimates of fish populations in streams. This, in turn, would lead to more accurate estimates of the values fishermen place on both the number and size of each fish species. Additional sites would also make it possible to evaluate fishing regulations such as minimum size, catch limits, or restricted gear. Careful selection of sites could also be used to evaluate public launch sites, fish stocking, and other public expenditure programs.

In summary, the success of this and other similar studies suggest that game managers now have available sophisticated evaluation tools in the simple and hedonic travel-cost methods. A large-scale regional survey using these methods could prove an invaluable asset for state and federal fish and wildlife management programs.

APPENDIX A

ASSESSMENT OF METHODS FOR VALUING THE POTENTIAL LOSS OF FISH POPULATIONS IN THE SWAN RIVER DRAINAGE

Revised Version of a Working Paper
Originally Submitted to the Montana Department of
Fish, Wildlife, and Parks
on 30 June 1983 Entitled:

LITERATURE REVIEW OF

METHODOLOGIES TO EVALUATE RECREATION

ASSOCIATED WITH FISH IN THE SWAN RIVER DRAINAGE

I. INTRODUCTION

Our task in this study is to estimate the value of the loss to society associated with the likely reduction of fish populations when small hydroelectric projects are constructed on tributaries of the Swan River. The most useful techniques for such an estimation have been developed by economists, and reported in numerous professional journals. In this appendix we describe eight techniques and assess the ability of each estimate the value of a partial loss of a fish population. The eight techniques we assess are gross expenditure, travel cost, own-price-quality travel cost, demand-system travel cost, gravity model, hedonic travel cost, household-production-function, and contingent valuation.

II. DISCUSSION OF AVAILABLE ANALYTICAL TECHNIQUES

A. GROSS EXPENDITURE

The gross-expenditure method infers the value of a recreation site from the total of all expenses related to trips to the site. Expenses would include meals, lodging, equipment, clothing, ammunition, bait, guide services, rentals, and transportation. The value of a day spent by a user at a site is the total of all the expenditures made over the day. Thus, the annual value of a site would be the sum of all the expenditures for all the trips made by all users to the site.

The technique looks at gross expenditures, that is, all expenditures made on a trip to a recreation site. Included are purchases of goods not directly related to the value of the site. For example, a user not only purchases access to some Site A, but he also buys a steak dinner and sleeps in a hotel with a pool. All the costs of these other goods (the dinner and lodging) are mistakenly lumped together with the value of the site. A user might like Site B 20 dollars more than Site A, yet spend 30 dollars more on Site A trips than on Site B trips because of the great restaurant and motel near Site A. It is the restaurant, not the quality of Site A, which drives the gross expenditures. We could not conclude that the recreation provided at the site is superior at Site A, even though gross expenditures were greater.

The gross-expenditures method is a poor tool for valuing outdoor recreation sites. Too much of the variation in gross expenditures is related to the purchase of other goods not directly related to the site. There is no reason to believe that sites that are the destination of more expensive trips are necessarily more valuable.

B. TRAVEL COST

One component of gross expenditures, the travel cost to a recreation site, can help evaluate the site. The travel cost from residence to the site is part of the cost of using the amenities the site offers. In fact, travel cost is part of the cost of all of our daily purchases, such as vegetables, clothes, and movies. For typical consumer goods, however, the distance traveled tends to be small, especially relative to the purchase price of the good once at the destination. Thus, we tend to ignore travel cost when thinking about the price of traditional goods, even though it is non-zero. For outdoor recreation sites, though, the purchase price is usually zero or very small, whereas the distance traveled can be quite large. For outdoor recreation, one can often ignore purchase price and instead focus on travel cost as the price of a site.

In a given season, people will continue to travel to a site until the value of one more trip is no longer greater than the price. The same principle applies to all other goods purchased in the market: people continue to buy more of something until the value to them of the last (marginal) unit purchased is equal to its market price. Stated another way, people try to spend the dollars they have (their budget) on the mix of goods and services they think will make them as happy as possible. The extra relative happiness they receive from the last good purchased is reflected in the relative price of that good. Thus, the value to a user of <u>last</u> trip he makes to a site is equal to the price of that site, which is equal to the cost of traveling to that site.

Note the emphasis on "last" trip (economists call this the "marginal" trip). What about the value of previous ("inframarginal") trips? The inframarginal trips are generally worth more than the marginal trip. For example, the last ten gallons of water someone purchases on a given day might be worth only 1/2 cent, the price of the water. But she might have purchased a total of 75 gallons. If we restricted her consumption to 20 gallons, the 20th gallon would likely be worth more than 1/2 cent. If we restrict her to 1 gallon, she is likely to be willing to spend a great deal more than 1/2 cent per gallon to be allowed 2 gallons. For almost all consumption goods, people value an extra unit of the good less and less the more of the good they have. Thus, a fisherman's sixteenth trip to a fishing hole is not worth as much to him as his first trip was.

The critical issue in determining the value of a site is estimating how much more than the marginal trip the inframarginal trips are worth. The net value of a site is the difference between the benefits it provides and what users pay to get those benefits. What they pay is travel cost, which we assume does not depend on the number of trips made (i.e., the cost of marginal and inframarginal trips are equal). For every inframarginal trip, users get benefits beyond the value of travel costs. The sum of these extra benefits to all users is the net value of a site.

How does one measure the value of inframarginal trips? Looking at the behavior of a single individual facing a single price for trips, it is impossible to measure the value of inframarginal trips. All we know is that the inframarginal trips were worth taking (that they were at least as valuable as the travel cost to the site). We could ask a person about the additional value of these earlier trips, but such valuations are unreliable. Economists prefer to observe actual behavior rather than answers to hypothetical questions. (We discuss this later in the section on Contingent Valuation.) The travel-cost method developed by Hotelling (1949) and Clawson (1959) infers the value of inframarginal trips by observing the number of trips made to a site by people who live different distances from the site. Because they live different distances, they face different prices (travel costs) for use of the site. If we assume the people are otherwise alike (a strong assumption), then the different number of

trips people take result entirely from the different prices (distances) they face. We can infer the value of the inframarginal trips for a person close to the site by looking at the value persons far from the site place upon their own marginal trips. For example, if people from 100 miles away go to a site once, the first trip (at $.20 per mile) is worth $40 (2 x 100 x .20). If people 90 miles away go to the site twice, the second trip is worth $36. If people take a third trip when they are only 80 miles away the third trip is worth $32. Figure 1 shows this relationship. The inframarginal value of trips can be measured by looking at the marginal value (which is observable) of users who took fewer trips.

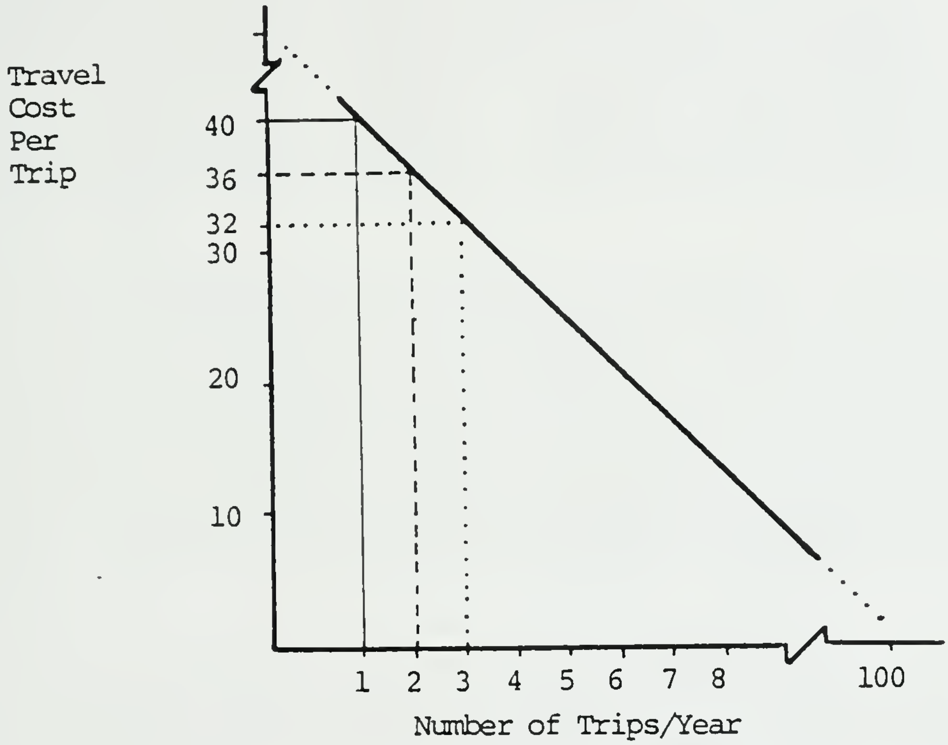


Figure 1. Annual Demand for Trips

The value of a given site to a user is the amount above the travel cost she will pay for each trip. The net value of the marginal trip is zero. For example, if one took the above site away from the people who lived 100 miles away, they would lose a

trip which they value at $40, but they would save $40 of expenses. The net loss to these people is zero. If one takes the same site away from the people who live 80 miles away, they would lose three trips. The first trip they would value at $40, the second at $36, and the third at $32. On the other hand, they would save the travel expenses of three trips. The net loss would be $12 (($40 + $36 + $40) - (3 x $40)). Twelve dollars is what the users 80 miles away would pay for the all or nothing privilege of having the site exist. This net value is the consumer surplus of trips to the site--it is an appropriate measure of the value of a site. The sum of the consumer surpluses for all users gives an estimate of the net value of the site.

The travel-cost approach has several problems, some of them stemming from its underlying assumptions. First, to evaluate inframarginal trips the approach assumes that people at different distances from the site are similar. If this assumption is violated, then it is no longer possible to assume that everyone values the first trip the same. The price of the marginal trip for the people who take only one trip would no longer be an appropriate measure of the value of the first trip of people who take more trips.

A second problem can arise from the assumption that travel costs are incurred solely to arrive at the site. If people visit multiple sites, then part of the reason for making the travel expenditure is to enjoy the other sites. Attributing the entire travel cost to the target site would overstate what the person is willing to spend for the marginal trip to it. Also, since people from farther away are more likely to engage in multiple-purpose trips, it is possible to overvalue the first few trips users make and thus overestimate the consumer surplus of trips--the value of the site. Ideally, the analysis should be limited to single-purpose trips.

A third problem of the travel-cost approach is that it is difficult to determine travel cost per mile. Some users may look at their travel choices solely in terms of the out-of-pocket costs of the trip--the extra gasoline. Others may include maintenance and insurance costs. Others could value a mile driven at the same costs of renting a car. Some may also value the time spent traveling. Thus, the possible values for a mile driven could range from a few cents a mile to a dollar or two, depending upon the definition of travel cost. The estimated value of the site will vary in proportion to the value chosen for travel cost per mile.

(Note that other techniques we will describe are also plagued by these three problems. Revealed-preference techniques (such as the own-price-quality, demand-system, and hedonic travel-cost models) all are built on the travel-cost model. The household production function and gravity models also depend upon these same travel-expenditure assumptions to infer values.)

A fourth problem with the simple travel-cost model is that it measures the all-or-nothing value of a single site. For example, using travel cost one could estimate the total recreational value of the Swan River drainage. This would certainly serve as an upper bound of the value of a loss in fish population in the drainage. But the Swan River drainage, even with the reduced fish population, would nonetheless continue to provide recreational services. The total value of all recreation services in the drainage may grossly overestimate the partial loss of service that results from the reduced number of fish. The simple travel-cost technique is designed to value sites, not changes in the sites. As a measure of the value of fish, it is a biased upper bound.

C. OWN-PRICE-QUALITY TRAVEL COST

The own-price-quality travel-cost model was first developed by Vaughn and Russell (1983). The model is an extension of the simple travel-cost model to include quality of the site. With the own-price-quality model, the number of trips (Q_i) to a specific site is assumed to depend only on the price of getting to that site (P_i) and its quality (Z_i):

$$Q_i = f_i(P_i, Z_i)$$

$$Q_j = f_j(P_j, Z_j).$$

The model is appropriate if people have only one site to choose from in their region and if sites in different regions have different qualities. In a world with substitutions, however, we expect the prices and qualities of alternative sites to affect the number of trips a person would make to a specific type of site. The own-price-quality model assumes these substitute sites have no effect. In other words, each site draws consumers independently of all other sites. People living in residential areas close to a multitude of possible recreation sites will be very busy recreating: going to one site has no effect on their demand for recreation at any other site.

An advantage of the own-price-quality model is that it requires only a minimal amount of data. If one can reasonably assume that alternative sites are of little importance, the approach offers an easy methodology to evaluate quality. The quality parameters simply shift the demand for trips. The value of the quality improvement is just the added consumer surplus (see the shaded area in Figure 2) above the travel cost, summed for all users.

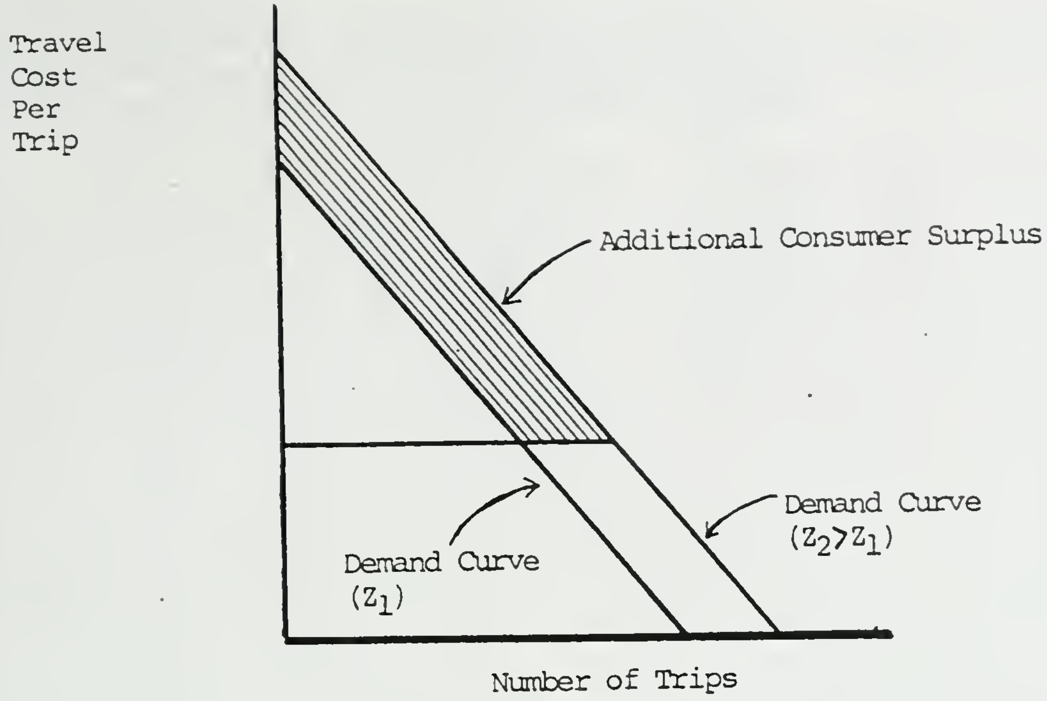


Figure 2. Demand for Quality

D. DEMAND-SYSTEM TRAVEL COST

The demand-system travel-cost model has been applied by Burt and Brewer (1981) and by Cichetti, Fisher, and Smith (1972). It looks at systems of sites instead of individual sites. Types of sites are ranked according to objective characteristics such as size, elevation, water resources, and other physical attributes. The number of trips the consumer makes to each type of site is then compared not only to the cost of that site (the travel cost), but also to the cost of alternative sites. For example, the number (quantity) of trips a consumer makes to some site i (Q_i) depends upon the travel cost to (price of) of that site (P_i), as well as the price of substitute sites (P_k). We represent this relationship as:

$$Q_i = f_i(P_i, P_k, W)$$

$$Q_k = f_k(P_i, P_k, W),$$

where W represents demographic differences among users that might influence their desire to visit the site (such as their age, sex, or income).

The demand-system approach offers two improvements over the simple travel-cost method. First, the demand system, by taking account of substitutes explicitly, does a better job of measuring the value of any single site. Clearly, the demand for a nice, medium-sized lake will be different if the lake is located in Minnesota or Arizona (where there may be thousands or only a handful of substitutes). Secondly, the demand system offers a chance to value changes in the nature of the site. As long as

one is considering changing an existing site, say i, to physically resemble another existing site, say k, the value of the change can be measured by the demand system.

Figure 3 shows how, in concept, such a measure would be made. The first graph shows demand for site type i, the second for site type k. Assume in this example that type k is higher quality. If we change a type-i site to resemble a type-k site, we expect two major effects. First, there is now one less type-i site and one more type-k site. Some people will now have to travel farther to find a type-i site (because the one they used to go to is now type-k) and some people will now have shorter trips to find a type-k site (for similar reasons). The horizontal dotted lines shows the effect on a hypothetical marginal travel cost: the cost curve increases (rises) for the type-i site, and decreases (lowers) for the type-k site. Secondly, substitution occurs because the price of the type-k site has dropped relative to the price of the type-i site: the demand curve moves in for the type-i site, and moves out for the type-k site. Consumer surplus (the area in the triangle made by y-axis and the new demand and cost curves) decreases at the type-i site and increases at the type-k site. The net gain in consumer surplus is the value of the increase in quality from type-i to type-k.

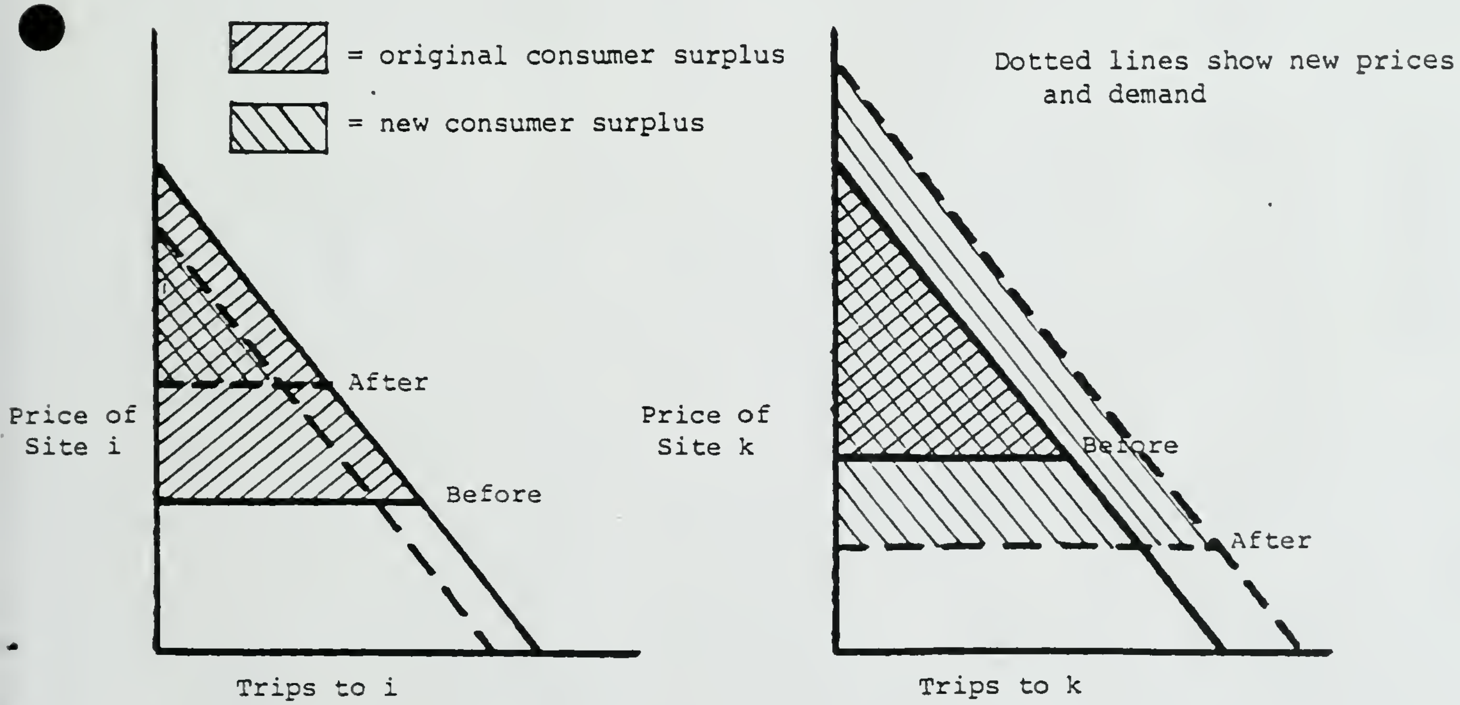


Figure 3. The Value of Changing a Site From Type i to Type k

The demand-system travel-cost method could be used to value change in fish population if it is possible to identify types of existing sites which resemble the transformed site, and if data are available about use of a wide variety of sites.

E. GRAVITY MODEL

The travel-cost model was developed to evaluate sites; the gravity model was developed for transportation engineers to predict travel burdens on highway networks. In principle, the two models are identical. The sophisticated gravity model uses a person's demand for trips to predict the number of trips she will take and where she will go.

The simplest gravity model predicts trips in terms of the quality of the site (Z) and the cost of getting to site j from residential location i (the travel-cost function, $f(C_{ij})$):

$$T_{ij} = KZf(C_{ij})$$

where T_{ij} is the number of trips per capita and K is a constant. Note the similarity between this model and the own-price-quality model. An implicit assumption of the model is that the number of trips from each residence i to each site j is not affected by any other possible sites.

Another common gravity model predicts trips in terms of the relative quality of each site to all other sites. Total trips are assumed exogenous (i.e., they are not derived by the model, but are inputs to it). The model merely allocates the total across the available sites (m sites):

$$T_{ij} = KZf(C_{ij}) / \sum_{n=1}^{m} (Z_n f(C_{in}))$$

The model is more realistic in its handling of the interrelationship across sites because it explicitly acknowledges the relevance of substitutes. That benefit is offset by its assumption that total trips are exogenous; one would expect that total trips would depend on the opportunities facing residents at i.

The most general gravity model resembles the advanced travel-cost models (demand-system and hedonic travel cost). The trips function has the following form:

$$T_{ij} = Kg(mZ_n f(C_{in})) \cdot h(Z_j)f(C_{ij}) / \sum_{n=1}^{m} Z_n)f(C_{in}).$$

where f( ) is the travel-cost function, g( ) is a function for total trip opportunities, and h( ) is the site-characteristic function. The division of trips across sites depends upon both the site's characteristics and the travel cost relative to those of other sites.

The exact functional form assumed for $f(C_{ij})$ and $h(Z)$ determines the shape of the underlying demand curve. Though users of the gravity model tend to assume reasonable functional forms, they often restrict themselves to unnecessarily rigid specifications. They also have failed to construct adequate submodels of the role of site characteristics $h(Z)$. For example, Cesario and Knetsch (1976) use an attractiveness index which they define subjectively based on the popularity of the site. They did not estimate the correlation between attractiveness and objective characteristics. Further, there is a possibility that attractiveness may reflect site access, a variable supposedly captured by the travel-cost function $f(C_{ij})$. Finally, most users of the gravity model appear to be unaware that the specification of the gravity model implies a particular underlying demand function. For example, Sutherland (1982), estimates both a demand function and an inconsistent-trip generation function in the same analysis. The trip generation function recognizes substitute sites whereas the demand function does not. The estimated shapes of both functions are inconsistent with each other. The true tastes which generated the trip function could not have also produced the estimated demand function.

The primary use of the gravity model is to estimate trip generation for the purposes of transportation planning. For valuing recreation, those trips must still be transformed into a demand function for recreation. Consequently, it is generally preferable to estimate the demand-for-trip model directly.

F. HEDONIC TRAVEL COST

The hedonic travel-cost method, developed by Brown and Mendelsohn (1980), combines the hedonic procedure now familiar in the literature of urban and labor economics with the traditional Hotelling-Clawson travel-cost method. Recreation sites are viewed as bundles of homogeneous characteristics. For each trip the price or cost of purchasing a bundle for a trip is the marginal travel cost from an origin to the recreation site. By examining the variety of purchases of a group of people from a single origin, one can to estimate the marginal expenditures necessary to purchase additional units of each characteristic. Armed with these "prices" of characteristics, one can estimate the demand for each by comparing origin residence zones which have varying access to sites.

The initial step of the technique is to estimate the price people must pay to obtain more of each characteristic. By regressing travel costs upon the bundle of characteristics people can purchase at each site, it is possible to estimate these

marginal prices for each characteristic. Thus, for the set of plausible sites facing each residence area (each origin), one performs the following regression:

$$V = f(Z_1, Z_2, \ldots, Z_n)$$

where V is travel cost and Z_i is the level of each characteristic. As discussed in the travel-cost section, the travel cost is the total cost of traveling from the residence to the site. It includes time cost, out-of-pocket expenses, and wear-and-tear on the vehicle. The exact dollar value per mile to place on travel cost is somewhat uncertain making the final dollar values of site characteristics uncertain as well. The probable value, in 1982 dollars, is about $.25/mile.

Every characteristic of importance should be included in the analysis. Data limitations, however, often force the analyst to choose from a more limited set. In the case of Montana fishing sites, it is probably adequate to choose three variables: fish density, fish size, and scenic quality. Fish density--the availability of fish--can be conveniently measured in average catch per unit effort (e.g., catch per ten days fishing). Because this measure is supposed to reflect the quality of the site and not the skills of the fisherman, catch rates should be averaged across all the sampled fishermen at each site. To value specific types of fish, separate estimates of fish density must be made for each species. The same is true of fish size (average size of catch). Scenic quality is more difficult to measure objectively. In practice, it might be sufficient to identify whether a site has below-average, average, or above-average scenery.

Having performed this initial step for each residential site in the sample, one can calculate the price each person in the sample faces for each characteristic. This price describes how much a person is willing to pay to improve each characteristic slightly. For small changes in site characteristics, these prices provide a reasonable measure of site changes. For example, if the price of fish density were $1.25 per catch per twenty days, and mean catch per 20 days were reduced from 10 to 9, the value of the change would be $1.25 per trip. To estimate the total value of the site change, one would simply multiply the $1.25 per trip times the total number of trips to the site.

For large changes in site quality, the price becomes an increasingly inaccurate measure of the change. For major improvements (deterioration), the price overestimates (underestimates) aggregate value. Large changes affect the price of the characteristic so that it is no longer desirable to value quantity changes at a single price. For large changes in the site, it is desirable to include the effect of price changes in a measuring consumer surplus. Consumer surplus is the area under the demand curve and above the cost curve (P): the value of the recreation to consumers after travel costs have been subtracted (see Figure 4). To measure the consumer surplus of a

large change in a site characteristic (for example, a decrease from Q_1 to Q_2) one must first estimate the demand for the relevant characteristic. The value of the change (in this case, a loss) in quality is the change in (loss of) consumer surplus (the shaded area) associated with the price change from P_1 to P_2. In this study, the relevant issue is the demand for and consumer surplus of fish density.

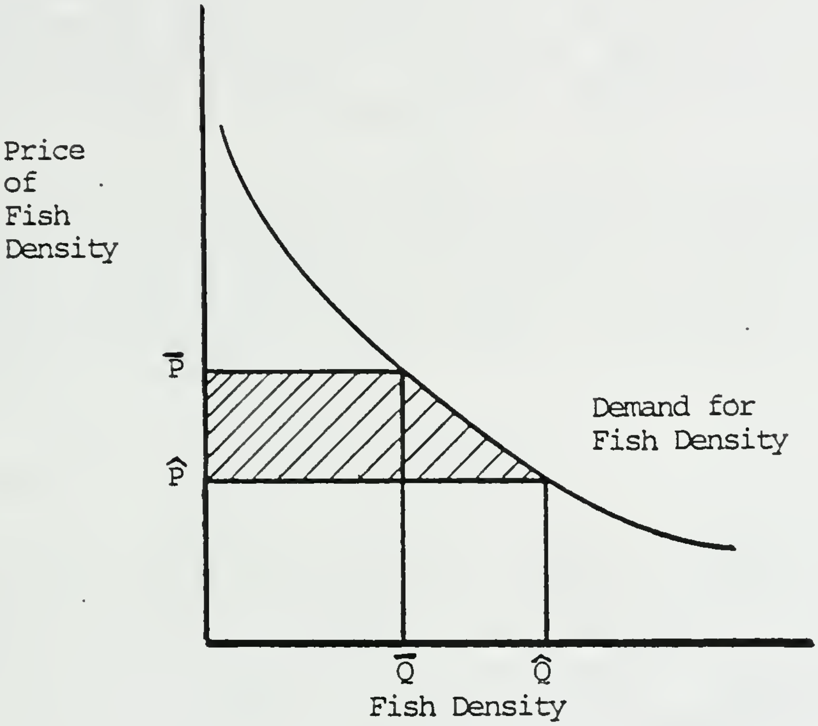


Figure 4. Consumer Surplus of Fish Density

We can estimate demand for fish density by observing how much fish density is purchased by users who face different prices for fish density. That is, by comparing the behavior of near and far fishermen, we estimate how fishermen value access to the fishery. Removal or enhancement of a site, after all, only changes how far

the fishermen must drive to obtain a site of the desired quality. The inverse demand (where the inverse demand function describes what the consumer is willing to pay for each level of characteristics) for the fish density of each species can be obtained by regressing the price of the characteristics on the level of each characteristic:

$$P_1 = g(Z_1, Z_2, \ldots, Z_n, W)$$

where W represents demographic differences among users that might influence their desire to visit a site. The equation above is for estimating P_1, the price of characteristic Z_1; an additional equation would be estimated for each additional characteristic. This regression must be done across the entire sample, including all the residential zones in the same analysis. The shape of the estimated demand function, in turn, will lead to an estimated consumer surplus for any specified change in characteristics.

The advantage of the hedonic travel-cost method is that it focuses upon valuing site characteristics such as fish density. Consequently, it is designed to value exactly the good in question. The disadvantage of the approach is that it requires substantial data about site characteristics and user behavior. Such data are generally unavailable; a specific survey must be undertaken to collect them.

G. HOUSEHOLD-PRODUCTION-FUNCTION

Whereas traditional demand theory is concerned with the demand for goods observed to be purchased in the market place, the household-production-function approach concerns itself with goods produced at home. Households are perceived as suppliers of commodities which they in turn consume. They produce these commodities by combining purchased goods, household technology, and time. For example, a hunter might combine a site, ammunition, a rifle, and time to produce a day of hunting and a kill. Note that in contrast to the travel-cost methods, the focus of the valuation is not the site but rather what the household produces at the site. The purpose of the household-production-function approach is to value household outputs such as fish caught; it cannot directly value the fish population of each species. The amount a fisherman is willing to pay for the fish he takes home is a gross measure. This gross measure is the sum of what the fisherman is willing to pay for the fish population plus what it costs him to actually catch the fish. In our analysis of fishing in the Swan River basin, the desired social measure is the net value of fish--how much each user would pay to have the fish population increased (or not decreased). The gross measure is an overestimate of willingness-to-pay since the fisherman would still have his expenditures of money and time if he did not fish at all. To arrive at a net value, one must subtract the value of time and other expenses from the gross measure of catch value.

The mechanics of the household approach are similar to those of the hedonic travel-cost method. In the first stage, a cost function is estimated. The total expenditure of the trip (the gross expenditure including total time, not just travel costs) is regressed upon all the outputs produced. For a fishing trip, the obvious outputs are days fishing and catch. One must be careful, however, to include other possible objectives such as days of solitude, outdoor experiences, culinary events, or attractive lodging, which the fisherman may also be seeking in his trip. This regression allocates the expenditure made over the set of possible outputs. The partial derivative of this estimated cost function reveals the price of each output. Given exogenous demand-shift parameters which reflect only differences in taste, the demand for the output can be estimated in a second-stage regression.

The estimation of the demand for the outputs of the household production function are plagued by econometric difficulties. The absence of measured outputs tends to bias the estimation of the cost function. The household-production-function requires data about preferences that are hard to collect: getting a list of all the activities that provide pleasure during a recreation experience is difficult and expensive. It is also hard to distinguish between time as a cost (a lost opportunity to do something else, including work) and time as a measure of output (such as days fishing or hiking). Time spent is more likely to be integral to the experience the less is the total time available to achieve the experience. The presence of nonlinearities and joint production causes marginal prices to vary with the level of outputs purchased. The endogeneity of prices, in turn, leads to identification and selectivity bias problems in the estimation of the structual equations. All these problems confound the estimation of the household-production-function approach and prevent its useful application.

Given the difficulty of estimating the demand for the outputs of user activities, and given the policy need to estimate the demand for inputs (sites) rather than outputs, the household-production-function approach is not applicable. It is not user days which need to be valued, but fish populations. Alternative approaches such as the hedonic travel-cost method, which directly value inputs, are preferable to indirect methods that value outputs which then must be converted back to inputs.

H. CONTINGENT VALUATION

The contingent-valuation procedure, unlike the seven other methods mentioned here, does not depend on user behavior. Instead, the value of desired commodities is revealed by how a person responds to a battery of hypothetical questions. By constructing the correct set of questions, the researcher tries to get the individual to reveal the true values.

Although the contingent-valuation approach seems the most straightforward of the methods described, it is one of the most difficult of the approaches to apply. Contingent-valuation designs have six potential biases: hypothetical, strategic, payment-vehicle, starting-point, information, and interviewer bias.

Hypothetical bias refers to a random error that results from a respondent's answer not truly corresponding to observable behavior in a real situation. The problem arises because the person does not fully visualize the hypothetical setting, fails to account for all her feelings when put in such a setting, or does not wish to reveal her true values.

The strategic bias suggests the individual intentionally mis-states his preferences to force others to share his values. For example, someone who likes a certain public good has an incentive to overstate that preference in the hopes that the good's high value will ensure its continued provision.

Payment-vehicle bias reflects the fact that responses to questions of value are influenced by the method of payment and whether respondents are to pay or be paid. Payment-vehicle bias is often used to explain the large number of protest votes encountered whenever the contingent-valuation method is used. Payment-vehicle bias, by identifying who must pay, also explains the large discrepancy between what people offer to pay versus what they think they should be paid for changes in public goods. Neither answer reflects solely the value of the good; it also reflects a sense of values about how goods should be paid for.

Starting-point bias originates from willingness-to-pay questions that request specific amounts people must pay. By starting at $25 rather than $1, the survey question implies that $25 is a low bid. People sometimes respond accordingly, with the average bid rising proportionately with the starting bid.

Information bias originates from the "facts" presented in the hypothetical question. For example, if one begins by saying that air pollution is a known health hazard and ecological disaster, one obtains a different response than if one begins by stating that air pollution is a necessary by-product of our standard of living and causes little effect. The phrasing of the hypothetical situation consequently can alter the responses.

Interview bias arises from the fact that interviewers are different and can impose their values upon respondents. Untrained interviewers might rephrase questions to interpret them for the respondents. Depending upon the interpretation of the interviewer, a different set of responses would be forthcoming. If a researcher gives interviewers careful training, interview biase can be overcome.

To provide representative answers, questions must be phrased to avoid each of these potential pitfalls. Unfortunately, not enough is known about this art to assure the accuracy of any single survey instrument. At a minimum, a variety of questions should be asked. If all the responses are consistent, the survey instrument is, at least, robust. Additional comparisons between the survey method and alternative sources of information would also provide useful indicators of the validity of the method.

Although difficult to apply, the contingent-valuation method is clearly relevant to the valuation of fish population changes. By asking the correct battery of questions, it may indeed be possible to determine the value of such changes from the answers users provide.

III. CONCLUSION

To measure the net economic loss associated with the potential loss of fish population in the Swan River drainage, we propose to adopt three independent methodologies: travel cost, hedonic travel cost, and contingent valuation. The first two techniques estimate values based upon the observed opportunities and choices of users. The contigent evaluation method, in contrast, poses a set of hypothetical questions designed to elicit the true values of respondents. By adopting three separate approaches, we hope to increase the probability of making a reliable estimate and also compare the strengths and weaknesses of each methodology.

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APPENDIX B

ECONOMIC SURVEY FORM

INSTRUCTIONS (July 12, 1983)

Be sure to collect both creel and economic data from party leader since economists need both sets of information for their analysis. Make sure that party leader has not previously answered the economic questions (no repeat interviews, please). Ask party leaders all creel and economic questions verbally (except for last two) and try to get specific answers and completed forms. For the last two questions (hourly wage and family income), hand the survey form and wage card to the party leader and let him/her fill them in.

In question 1 on the economic survey, the zip code of the party leader's primary residence is requested. Occasionally, confusion results when a party leader's primary residence is out-of-state but he/she spends the summer in Montana. As a rule of thumb, if a person maintains a residence of any sort (motel, cabin, campground, RV park, house, etc.) in a fixed location in Montana for two months or more, then use that Montana zip code as their residence and consider their trip(s) as having originated from that location (i.e., for questions 3, 5, 10 b) and 10 c)). Otherwise, use their out-of-state zip code as their point of origin in answering subsequent questions.

Remember that question 10 b) refers to number of trips from home to the site(s) and not necessarily to number of days fished. Also, Question 10 c) refers to total miles driven from home to reach each fishing site.

CREEL CENSUS FORM INSTRUCTIONS

Interview only parties that fished for at least one-half hour on the census day or if they fished the previous day, then get creel and economic data for that day. Interview only heads of parties (party leaders).

COLUMN 1: Indicates last digit of survey year, i.e., 198<u>3</u>.

COLUMN 2-5: Fisherman identification number: This number is used to identify the fish caught by a party of anglers as well as to keep track of the number of parties interviewed. The I.D. number on the creel census form must correspond to the I.D. number on the fish form if biological data is collected on creeled fish.

COLUMNS 6-7: Area. Each lake or river is delineated into specific areas for the purpose of this census.

<u>Swan Lake</u>

11 North half
12 South half

<u>Swan River</u>

21 Swan Lake to Goat Creek bridge
22 Goat Creek bridge to Cold Creek bridge
23 Cold Creek bridge to outlet of Cygnet Lake

<u>Tributaries</u> (Enter name(s) in "COMMENTS")

30 Draining into Swan Lake
31 Draining into Swan River between Swan Lake and Goat Creek Bridge
32 Draining into Swan River between Goat Creek bridge and Cold Creek bridge
33 Draining into Swan River between Cold Creek bridge and outlet of Cygnet Lake
34 Draining into or upstream from Cygnet Lake

<u>Other Waters</u>

98 Other lakes in Swan drainage
99 Other waters

COLUMNS 8-9: Day.

COLUMNS 10-11: Month.

COLUMN 12: Day of week.

1:	Monday	5:	Friday
2:	Tuesday	6:	Saturday
3:	Wednesday	7:	Sunday
4:	Thursday	8:	Holiday

COLUMN 13: Party leader (place a "1" in this column for party leader - to be used in sorting data).

COLUMNS 14-15: Number of anglers in party.

COLUMN 16: Fish from shore or boat.

1: Shore
2: Boat
3: Ice

COLUMN 17: Type of bait.

1:	Bait (worms, etc.)	4:	Snagging hooks
2:	Flies	5:	Any combination of the above
3:	Lures		

COLUMNS 18-20: Hours fished

This is the total hours for the entire party in tenths of hours. If five people fished and two fished 5 hours, 2 fished 3 hours, and one fished 1 1/2 hours, the total would be (2 x 5) = (2 x 3) + (1 x 1.5) = 17.5 hours. For more accuracy, ask them specifically when they started and stopped fishing and if all people in the party fished the entire time.

COLUMN 21: Is fishing trip for that day completed?

1: Trip over
2: Not over
3: Don't know
4: Done fishing for day, but trip not over

COLUMNS 22-23: Origin

Origin of party is recorded for the following locations using these one digit codes. If party contains anglers from more than one origin, code them based on where the majority are from.

1: Kalispell
2: Other Flathead County
3: Lake County
4: Missoula County
5: Other Western Montana (west of Continental Divide)
6: Eastern Montana (East of Continental Divide)

7: Nonresidents (USA)
8: Foreign

COLUMN 24: Was interview data collected by roving creel clerk or at established checkpoint (i.e. checking station at fixed location along highway)?

1: Roving clerk
2: Checkpoint

<u>Fish catch - enter data for designated species</u>

COLUMNS 25-26: Number of cutthroat kept.

COLUMNS 27-28: Number of cutthroat landed. This is the <u>total catch</u>, and includes fish that were kept as well as those that were released.

<u>Repeat for each species</u>

COLUMN 49: Other species - enter one digit code. If species not on this list are caught, enter a "9" in Column 49 and the species name in "COMMENTS".

1: Brook trout
2: Grayling
3: Kokanee
4: Whitefish
5: Rainbow x cutthroat hybrid
6. Northern pike
7: Bass
8: Yellow perch
9: Other (write in comments)

COLUMN 50-51: Number of "Other Species" kept.

COLUMN 52-53: Number of "Other Species" landed (kept and released).

SWAN LAKE CREEL CENSUS AND ECONOMIC DATA FORM

YEAR	PARTY IDENTIFICATION NUMBER				AREA		DAY		MONTH		DAY OF WEEK	LEADER?	NUMBER OF ANGLERS		SHORE/ BOAT	BAIT TYPE	HOURS FISHED			TRIP OVER?	ANGLER ORIGIN		ROVING/ CHECK ST
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24

COMMENTS:

CUTTHROAT				RAINBOW				BULL TROUT				KOKANEE				NORTHERN PIKE				BASS				OTHER				
# KEPT		# LANDED		# KEPT		# LANDED		# KEPT		# LANDED		# KEPT		# LANDED		# KEPT		# LANDED		# KEPT		# LANDED		SP.	# KEPT		# LANDED	
25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53

PLEASE ANSWER ALL QUESTIONS.

1. What is the zip code of your residence? ___ ___ ___ ___ ___

2. What is your age? ___ ___

3. About how many miles (one-way) did you drive from your home (Question 1) to fish in the Swan River drainage? ___ ___ ___

4. How many of the individuals in your vehicle, including yourself, traveled here to fish today? ___ ___

5. Is fishing in the Swan drainage the main purpose of your trip from your home? (See response to Question 1.) Yes No

6. What was the main species (specific kind(s) of fish) you fished for today? ______________

7. Do you own or rent (for more than 2 months) a home in the Swan River Valley? (Circle one). Yes No

8. How many years have you been fishing? ___ ___

9. Considering all the places in Montana you've fished, would you rate the scenery in the Swan River basin

   (Circle one)

   above average?

   average?

   below average?

(continued on back)

10. We would like to know the names of the places (up to three places) in Montana that you fished most frequently <u>last year</u> and we would like to ask you a few questions about each place. (One or more of these places may be in the Swan drainage.)

		Site #1	Site #2	Site #3
a)	Site: Body of water:	________	________	________
	Nearest town:	________	________	________
b)	How many trips did you make from your home to this site in 1982?	___ ___ ___	___ ___ ___	___ ___ ___
c)	About how many miles did you drive one-way from your home to reach this site?	___ ___ ___	___ ___ ___	___ ___ ___
d)	What was the main species (specific kind(s) of fish) you fished for?	________	________	________
e)	On the average, how many fish did you land per day (includes fish kept, as well as fish released)?	___ ___ ___	___ ___ ___	___ ___ ___
	or			
	If the fishing was slow, how many days did it take to land a fish?	___ ___ ___	___ ___ ___	___ ___ ___
f)	What was the size of the biggest fish you caught? (inches)	___ ___	___ ___	___ ___
g)	Considering all the places in Montana you've fished, would you rate the scenery at this site			
	(Circle one)	above average?	above average?	above average?
		average?	average?	average?
		below average?	below average?	below average?

(continued on next page)

A

11. Assume that the fish population of the Swan River drainage might permanently decrease by 25 percent. If the only way to prevent this decrease was for fishermen to donate into a special fund to be used exclusively for this purpose, how much money would you be willing to pay into this fund each year? ______

12. If the fish population in the Swan drainage decreased by 25 percent, how many more miles one way would you be willing to drive to get to a site whose quality is as good as the Swan's before the quality decreased? ______

13. Which of the following categories most closely approximates how much you could earn per hour if you worked today instead of fished? Or, if you are presently not working, how much would you expect to make if you were to get a job today? (See Card For Wage Categories). ______

14. Which of the following categories most closely approximates the income of your family in 1982? (See Card For Income Categories). ______

B

11. Assume that the fish population of the Swan River drainage permanently decreased by 25 percent. If a special fund was created to be used exclusively to compensate fishermen for this loss in the fishery, how much money from this fund would you have to be paid each year? ____________

12. If the fish population in the Swan drainage decreased by 25 percent, how many more miles <u>one way</u> would you be willing to drive to get to a site whose quality is as good as the Swan's before the quality decreased? ____________

13. Which of the following categories most closely approximates how much you could earn per hour if you worked today instead of fished? Or, if you are presently not working, how much would you expect to make if you were to get a job today? (See Card For Wage Categories). ____________

14. Which of the following categories most closely approximates the income of your family in 1982? (See Card For Income Categories). ____________

QUESTION 13 - HOURLY WAGE

CATEGORY	HOURLY WAGE
A	$ 0 - 2.50
B	2.51- 5.00
C	5.01- 7.50
D	7.51-10.00
E	10.01-12.50
F	12.51-15.00
G	15.01-17.50
H	17.51-20.00
I	20.01-30.00
J	$30.01 +

QUESTION 14 - FAMILY INCOME

CATEGORY	FAMILY INCOME
A	$ 0 - 5,000
B	5,001- 10,000
C	10,001- 15,000
D	15,001- 20,000
E	20,001- 25,000
F	25,001- 35,000
G	35,001- 45,000
H	45,001- 60,000
I	60,001-100,000
J	$100,001 +